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ABSTRACT

The document is one of seven volumes of instructional materials developed around a cluster of Transportation Industries. Primarily technical in focus, they are designed to be used in a cluster-concept program and to integrate with a regular General Education Development (G.E.D.) program so that students may attain an employable skill level and a general academic background simultaneously. They provide basic skills necessary to enter a number of occupations in the Transportation cluster rather than an indepth development of skill in any one occupation. The volume contains approximately 120 hours of instruction in Automotive Services 2 and consists of 20 instructional units, each having one or more specific lessons. Each unit is designed for six hours, or one day, of instruction: three hours of technical laboratory instruction and three hours of related study in science, math, communications, and social studies. In most cases, there is only one lesson per unit. The units offer the instructor the essential materials: the aims (both in technical areas and in the four general education areas), instructional aids, topical outline and activities, suggested time sequence, evaluation guidelines, summary, and references. A selected bibliography concludes the volume. (Author/AJ)

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VOCATIONAL EDUCATION
PROGRAM OF STUDIES

Elementary, Secondary Education Act

Title I

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TRANSPORTATION CLUSTER
VOLUME II

CE006812

January 1, 1971
Pennsylvania Bureau of Correction

Harry A. Snyder
Director of Education

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INTRODUCTION

The following information comprises one of seven volumes of instructional materials developed around a cluster of Transportation Industries and Occupations. These instructional materials are primarily technical in focus but are written to be used in a cluster concept program as part of an integrated curriculum.

The materials are aimed at preparing students with basic skills necessary to enter a number of occupations in industries within the Transportation cluster rather than providing an in-depth development of skill in any one occupation.

Each volume contains approximately one hundred twenty hours of instruction (about one month of study) and consists of twenty instructional units each having one or more specific lessons. Each unit is designed for six hours of instruction (three hours of technical laboratory experiences and three hours of related study in science, math, communications and social studies) but may be varied at the instructor's discretion.

The seven volumes or cluster areas in the series are:

Volume I - Automotive Services I
II - Automotive Services II
III - Small Power Sources
IV - Driver Training
V - Pneumatics, Hydraulics and Fluidics
VI - Farm and Earthmoving Equipment
VII - Transportation Systems

Students in the Transportation cluster should be introduced to the technical and integrated content through several methods closely related to the industrial structure. Among these are line production and assembly, group projects, experimentation, unit studies and independent study. Team teaching techniques should be employed between the academic specialist and the technical specialist and coordinators.

It is recommended that an orientation program be offered students to familiarize them with the cluster areas available so they may select one they wish to pursue. The cluster instruction is designed to integrate with the regular G. E. D. program so that students may receive an employable level of skill and a general academic background simultaneously.

As students select the technical cluster areas they wish to study, they should have the option to move through the G. E. D. content at their own speed using programmed instructional materials, instructional television, computer assisted instruction and other individualized learning techniques. Technical and integrated concepts are introduced each day by the specialists involved.

After completion of one or more months of work within one cluster, a student could elect to study within another cluster providing, of course, this transfer is agreeable with the counselors, coordinators and instructors involved.

Lessons have been identified in the units. In most cases, however, there is only one lesson since each unit is limited to one day or six hours of instruction. The units offer the instructor the essential materials, vis-a-vis the aims, instructional aids, topical outline and activities, suggested time sequence, evaluation guidelines, summary and references. The primary and supplemental references are directly related to the topics and are important to the instructors. A selected bibliography is attached at the end of each volume as recommended additional sources of information.

Pagination of the units in this volume has been identified by cluster (T), volume (I, II, etc.), unit (1, 2, etc.) and page (.1, .2, .3, etc.) within each unit.

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INSTRUCTOR'S UNIT PLAN

Unit 1
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **General Automechanics**

AIM: To develop an interest in automotive mechanics as a technical service which offers a variety of possibilities for employment.

TEACHING AIDS:

Handouts, organization chart of an automotive dealership.

EQUIPMENT:

Transportation for class field trip to a modern automotive and truck service center.

PRIMARY REFERENCES:

1) **Occupational Outlook Handbook.** Washington, D. C.: U. S. Government Printing Office, 1968.

2) **Sextant Series, The.** Milwaukee: ALP Publications, Inc., 1968.

3) Stockel, Martin W., **Auto Mechanics Fundamentals,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

4) Venk, Ernest A., **Automotive Fundamentals,** Chicago: American Technical Society, 1967.

I. INTRODUCTION and MOTIVATION

A. Hand out organization chart and discuss potential salary scales at each branch of the chart. Call attention to the need for specialized services in various phases of automechanics.

B. Prepare students for field trip to local auto and truck service center.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. General scope of occupations in automotive service industries.	1. Automotive industries employ one out of seven workers in nation. 2. Management level occupations. 3. Employee level occupations	1. General overview of science principles applied to the automobile.
B. General mechanic (light repair)	1. Responsibilities are primarily: a. New car servicing. b. Light tune-up, minor repairs and adjustments. c. Periodic services such as lube and grease jobs, seat covers, etc.	
C. General mechanic (heavy repair)	1. Responsibilities are primarily: a. Disassemble, check, repair or adjust, and reassemble engines and units such as transmissions, differentials, and accessory systems.	1. Should understand basic principles of torque, pressures, fluids, viscosities, etc.
D. Specialist mechanic	1. Need for specialists in automotive service. 2. Basic responsibilities for:	1. General safety practices pertaining to each of the positions.
1. Tune-up specialist.	a. Ignition system, carburation, alternator, regulator, battery, and starter service. Needs skill in electronic diagnosis.	
2. Brake specialist.	b. Brake lining installation and cam grinding, drum turning, wheel and master brake cylinder repair and rebuilding, shoe adjustment, bleeding and trouble-shooting system.	
3. Front-end suspension and alinement specialist.	c. Wheel alignment and adjustment, shock absorbers, torsion bars, springs, and front-end assemblies.	
4. Transmission and rear-end specialist.	d. Standard and automatic transmissions, shifting, linkages, universals, differentials, and rear axle assemblies.	
5. Electrical systems specialist.	e. Generators, alternators, starters, regulators, motors, instruments, gauges, radios and tape decks, and electrical accessories.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Determine salary and number of hours work involved in various occupations.		1. Line and staff structure of industrial personnel.
	1. Reading and understanding repair orders and parts lists.	
1. Figuring time, labor cost, parts costs, and itemized bills.	1. Should be able to explain mechanical problems to service manager and customer.	1. Importance of self concept in the industrial labor force.
1. Measuring accurately with gauges, micrometers, and electronic instruments. 2. Wage differentials based on supply and demand.	1. Read selected journals in automotives. 2. Read manufacturers specifications and recommendations.	1. Impact of diagnostic service centers on automotive dealers.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
6. Air conditioning and cooling system specialist.	f. Installation, purging and charging, repair, and adjustment of air conditioning equipment. Radiators replacement and repair, belts, thermostatic control and trouble shooting techniques.	
7. Body and fender specialist.	g. Cutting, welding, filling priming, painting,and replacement of parts.	
E. Supervisory positions.		
1. Shop foreman.	1. Must be generally skilled in automechanics. In charge of mechanical repair and service.	1. Needs general science background.
2. Service manager.	2. In charge of over-all garage service operations. Scheduling and arranging repair work. Mediator between customer and mechanic.	
F. Parts and accessories manager.	1. Orders and maintains running inventory of parts and accessories.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
	1. Importance of leadership ability, personality, and friendly relations. 2. Development of acceptable grammar and speech for communicating with public. 3. Ability to "handle" dissatisfied customers.	1. Upward mobility in the service industry. 2. Discussions of job descriptions and incentives. 3. Prevailing problem of employee attitudes toward his job.
1. Basic inventory records and techniques. Budgeting, accounting, and financing skills. 2. Filing systems for records.	1. Using parts numbers and codes as basic language in the service area.	

III. APPLICATION

A. Conduct field trip to automotive and truck service center. Interview mechanics and supervisory personnel for general information on how they feel about their job and their role in the service center.

B. Have students write a two-page paper describing their personal reactions to the visit.

IV. EVALUATION CRITERIA GUIDELINE

A. Why have the auto mechanic trades developed into specialized work areas?

B. How are the jobs of the mechanic . . . light repair and the mechanic . . . heavy repair different?

C. What qualities are needed for supervisory personnel? What can the mechanic do to help himself move up in the industry?

D. How does an individual enter the automotive trades? What level of skill is needed? What about the unions?

V. SUMMARY

Our country has been aptly referred to as "a nation on wheels." The very essence of our economic life and growth is largely dependent upon the continued improvement and advancement of the automobile. Many service jobs are present in an automotive service center and one's level or job position is dependent only upon skill, knowledge and experience.

VI. SUGGESTED TIME and SEQUENCE LISTING

20 minutes . . . Hand out organizational chart and explain relationship of positions.
20 minutes . . . Prepare for field trip.
140 minutes . . . Field trip.
160 minutes . . . Related study in science, math, communications and social studies.
20 minutes . . . Summary and discussion of field trip.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Aspley, J. C., **The Greatest Business in the World.** Chicago: The Dartnell Corporation, 1962.

2) **Automotive Service Station Attendant.** Largo, Fla.: Careers, 1963.

3) **Automobile Service Station Attendant.** Tallahassee, Fla.: Florida State Employment Service, 1961.

4) **Can I Get The Job.** Detroit: General Motors Corporation.

5) **Careers In The Retail Automotive Business.** Detroit: General Motors Corporation.

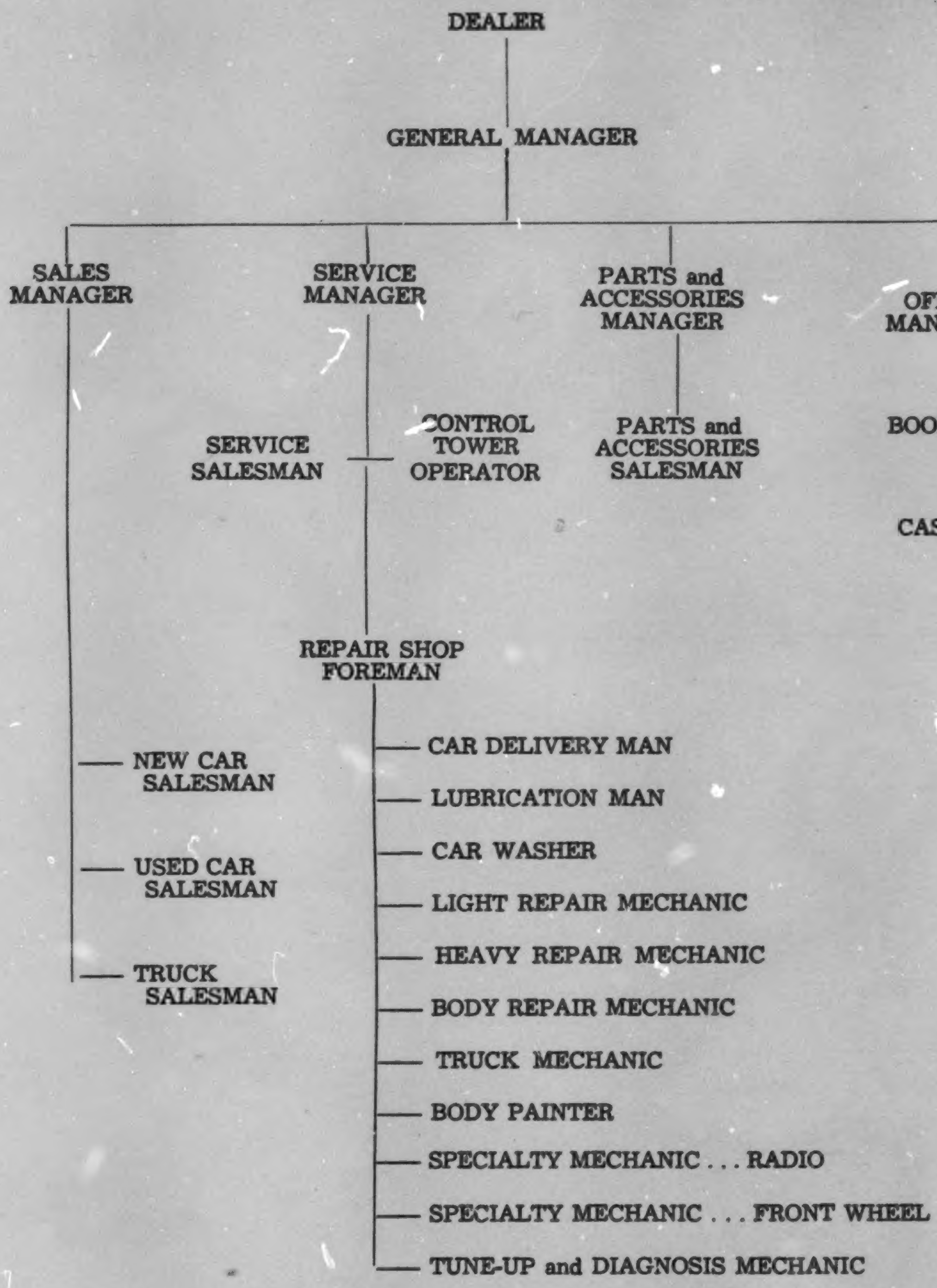
6) **Employment Outlook for Gasoline Service Station Attendants.** Washington, D. C.: U. S. Government Printing Office, 1964.

7) **Facts About Gasoline.** New York: Ethyl Corporation, Petroleum Chemicals Division.

8) Harrison, C. William, **Find a Career in Auto Mechanics.** New York: G. P. Putnam's Sons, 1964.

9) Moulton, Richard H., **Twelve Pointers That Lead to Promotion.** Littleton, N. H.: Executive Development Press, Inc., 1960.

10) **Opportunities in Automotive Service.** Detroit: Automobile Manufacturers Association, 320 New Center Building, 1963.


DEALER
GENERAL MANAGER
SALES MANAGER
SERVICE MANAGER
PARTS and ACCESSORIES MANAGER
OFFICE MANAGER
SERVICE SALESMAN
CONTROL TOWER OPERATOR
PARTS and ACCESSORIES SALESMAN
BOOKKEEPER
CASHIER
REPAIR SHOP FOREMAN
NEW CAR SALESMAN
USED CAR SALESMAN
TRUCK SALESMAN
CAR DELIVERY MAN
LUBRICATION MAN
CAR WASHER
LIGHT REPAIR MECHANIC
HEAVY REPAIR MECHANIC
BODY REPAIR MECHANIC
TRUCK MECHANIC
BODY PAINTER
SPECIALTY MECHANIC . . . RADIO
SPECIALTY MECHANIC . . . FRONT WHEEL
TUNE-UP and DIAGNOSIS MECHANIC

INSTRUCTOR'S UNIT PLAN

Unit 2
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Relationship of Automotive Systems**

AIM: To develop knowledge of the inter-relationships and functions of the various systems of the automobile.

INSTRUCTIONAL AIDS:

Charts - Training charts of the various automotive systems, Detroit, Mich.: General Motors Corporation.
Handouts - Prepared materials for trouble-shooting the systems.

EQUIPMENT:

Major components of the engine systems to be used for student study and inspection.
A late model automobile engine.

PRIMARY REFERENCES:

1) Allen, Willard A., **Know Your Car.** Chicago: American Technical Society, 1967, Second Edition.

2) Crouse, William H., **Automotive Mechanics.** New York: McGraw-Hill Book Company, Inc., 1965, Fifth Edition.

3) Frazee, Irving, et al., **Automotive Electrical Systems.** Chicago: American Technical Society, 1967.

4) Stockel, Martin W., **Auto Mechanic Fundamentals.** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

5) Stockel, Martin W., **Auto Service and Repair.** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1969.

I. INTRODUCTION and MOTIVATION

Elicit student responses relating to the automobile as a group of inter-related systems. Begin discussion on how these systems function and their unique contribution to the engine operation.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS
		SCIENCE
A. Power Plant. 1. Engine a. Fuel system b. Electrical system c. Cooling system d. Lubrication system	1. Fuel contains potential energy to be released during combustion in engine cylinders. 2. Electrical system functions to ignite fuel-air mixture. 3. Cooling system carries away heat produced by combustion. 4. Lubrication system functions to reduce friction within the engine and assist in cooling.	1. Combustion properties of various air-fuel ratios. 2. Combustion in confined space 3. Efficiency of various power plant systems. a. Gasoline engine. b. 1 stroke/cycle etc. c. 4 stroke/cycle d. LP gas engine. 4. Changing reciprocating motion to rotary motion.
B. Power transfer system. 1. Clutches a. Dry b. Fluid 2. Transmission a. Manual b. Automatic 3. Propeller shaft a. Exposed b. Enclosed c. Universal joints 4. Differential	1. The transportation of rotary motion. 2. The clutch transfers motion from engine to transmission. 3. The transmission as a device for gaining mechanical advantage and rotary speed. Also a device for reversing shaft rotation direction. 4. The propeller shaft as a transmitter of rotary motion. 5. Concept of universal joints. 6. The differential as a unit which allows each axle to rotate independently.	1. Mechanical advantage. a. Levers b. Gears c. Pulleys 2. Speed ratios of gears and gear combinations.
C. Braking Systems.	1. Hydraulic brake systems. 2. Drum-type brake systems. 3. Disc-type brake systems. 4. Power brake systems. 5. Servicing brake systems.	1. Concept of inertia. 2. Principles of hydraulics. 3. Friction and heat (brake temperatures).
D. Electrical System.	1. Components of the electrical system. 2. Function of the ignition coil. 3. Function of the distributor. 4. Function of the spark plug. 5. Function of the charging system. 6. Function of the starting system.	1. Electron theory of electricity. 2. Principles of low and high voltage. 3. Creating electricity by magnetism.
E. Fuel System.	1. Components of the fuel system. 2. Functions of the fuel pump. 3. Function of the carburetor. 4. LP gas fuel systems. 5. Fuel injection. 6. Super charging.	1. Evaporation concept. 2. Vaporization concepts (in the carburetor.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Ratio concepts of mixtures. 2. Percentage concepts for the understanding of power plant efficiency.	1. Technical terminology of the automotive engine. 2. How to talk to a customer. 3. Reading technical engine repair or service literature.	1. Historical development of the internal combustion engine. 2. Historical development of the automobile. 3. Study of specialized occupations relating to automotive engines.
1. Mechanical advantage ratios.	1. Technical terminology of the drive system.	1. Historical development of the automotive drive system. (Clutches, transmissions, etc.). 2. The effect of the Model "T" (the first mass-produced automobile) in our society. 3. Study of specialized occupations relating to automotive drive systems.
1. Problems of force and motion.	1. Development of vocabulary of automotive service industry. 2. Study of division of motor vehicle safety literature and research on stopping distances and braking.	1. The work of government and civic organizations in the area of automotive safety. 2. Study of specialized occupations relating to brake systems.
1. Ohm's Law and related electrical problems.	1. Study of electrical communications. 2. Development of vocabulary in electricity.	1. Study the effect electricity has had and is having on our lives. 2. Transportation of electricity by cross-country power lines. 3. Study of specialized occupations relating to automotive electrical systems.
1. Volume and capacity. 2. Air-fuel ratios. 3. Pressure.	1. Explain engine ratings by displacement and horsepower. Suggest to customer types of special care or service needed for different type engines.	1. Federal and state regulations concerning pollution control systems. 2. Study of specialized occupations relating automotive fuel and fuel systems.

III. APPLICATION

A. From charts and actual components, initiate discussion of various systems.

B. Use automobile to point out various systems and their relationships.

C. Discuss each system separately and its relationship to other systems.

D. Have students disassemble, inspect, reassemble and adjust engine components.

IV. EVALUATION CRITERIA GUIDELINE

A. Why is 100% of engine power not present at the rear wheels of the automobile?

B. What is the purpose of the transmission and how is this accomplished?

C. Why must the rear axles of the differential rotate independently?

D. Identify and describe the function of each of the automotive systems.

V. SUMMARY

The automobile is a unit of integrated systems. A service mechanic must be competent in all systems but may be specialized in one or more areas. All the systems must operate satisfactorily to have a safe efficient vehicle.

VI. SUGGESTED TIME and SEQUENCE LISTING

60 minutes ... From system charts, lead discussion to identification of systems and components of systems.

120 minutes . . . Using actual automobile, point out and discuss systems and components and their relationships.

60 minutes . . . Integrated science concepts.

40 minutes . . . Integrated math concepts.

40 minutes . . . Integrated communications concepts.

40 minutes . . . Integrated social studies concepts.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Bachman, Frank P., **Great Inventors and Their Inventions,** New York: American Book Company, 1946.

2) Beeler, Samuel C., **Understanding Your Car,** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1967.

3) DeCamp, L. Sprague, **Engines: Man's Use of Power,** New York: Affiliated Publishers, 1959.

4) Glenn, Harold T., **Exploring Power Mechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

5) Glenn, Harold T., **Power Mechanics Workbook:** based on the textbook: **Exploring Power Mechanics,** Peoria, Ill.: Charle A. Bennett Company, Inc., 1967, Second Edition.

6) Mann, Martin, **How Things Work,** New York: Thomas Y. Crowell Company, 1960.

7) Stephenson, George E., **Power Technology,** Albany, New York: Delmar Publishers, 1968.

INSTRUCTOR'S UNIT PLAN

Unit 3
Lesson 1
Time . . . . . 6 hours

CLUSTER:	TRANSPORTATION
DIVISION:	AUTOMOTIVE SERVICES II
SUBJECT:	**The Automobile Engine**
AIM:	To develop a knowledge of the various types of automobile engines and their supporting systems.

INSTRUCTIONAL AIDS:

Film - **ABC of Automobile Engine.** 405 Montgomery St., San Francisco, California: General Motors Corporation, Public Relations Staff, Film Library, (16 mm, color, 21 minutes).

Transparencies - Teacher-prepared transparencies of engine designs.

Training Charts - Teacher-made, showing the automotive engine and component systems.

EQUIPMENT:

16 mm film projector, overhead transparency projector and screen.

Automotive engines with supporting systems.

PRIMARY REFERENCES:

1) Bostwick and Barr, **Engine and Supplements.** Philadelphia: Chilton Books, 1967.

2) Frazee, Irving, et al., **Automotive Engines . . . Maintenance and Repair.** Chicago: American Technical Society, 1967.

3) Heldt, Peter, **High Speed Combustion Engines.** Philadelphia: Chilton Books, 1965.

4) Toboldt, William K. and Johnson, Larry, **Automotive Encyclopedia.** Chicago: The Goodheart-Willcox Company, Inc., 1968.

I. INTRODUCTION and MOTIVATION

Introduce and show **ABC of Automotive Engine.** Follow with discussion of the engine and its related components. Try to secure the General Motors cut-away engine which shows the internal function of the engine and its systems.

II. PRESENTATION OF INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Classification of engines. 1. Cooling: a. Air-cooled b. Water-cooled 2. Valve arrangement 3. Cylinder arrangement	1. Engine as integration of several systems 2. Air-cooled engine design. 3. Water-cooled engine design. 4. L-head engine configuration. 5. F-head engine configuration. 6. OHV engine configuration. 7. In-line cylinder block design. 8. V-type cylinder block design. 9. Opposed cylinder block design.	1. Concept of horsepower, torque, etc. 2. Engine efficiency and valve arrangement.
B. Supporting systems. 1. Fuel system 2. Ignition system 3. Cooling system 4. Lubricating system 5. Charging system 6. Starting system 7. Electrical lighting and accessories system	1. The fuel system purpose and operation. 2. The ignition system as two circuits: a. Primary circuit 1. Battery 2. Ignition switch 3. Resistor 4. Distributor b. Secondary circuit 1. Ignition coil 2. Distributor 3. High tension wires 4. Spark plugs 3. Automotive engines are either air or water-cooled. 4. Lubricating system reduces friction and helps cool engine.	1. Study of the internal combustion engine. 2. Cooling concepts . . . heat transfer.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Problems in work, torque, horsepower, etc. 2. Cost variation in engine designs.	1. Development of reading skills in technical engine publications (manufacturer's service guide). 2. Write request for display of the General Motors visiting engine exhibit showing cut-away of an operating engine.	1. Historical development of the internal combustion engine. 2. Effects of internal combustion (gasoline) engine on development of automobiles, railroad, airplanes, and ships. 3. History of automobile, truck, and bus development and its impact on social values, culture, politics, economics, and land value.
1. Introduction to Ohm's Law of electrical circuits.	1. Technical terminology in area of engine systems.	1. Responsibilities of serviceman to customer, organization, self.

III. APPLICATION

A. Using overhead transparencies, present various types of automotive engines.

B. Elicit student comparison of engines (from transparencies).

C. Present and discuss supporting systems and their inter-relationships to the power plant.

D. Conduct laboratory identification of engines and supporting system components of actual engines.

IV. EVALUATION CRITERIA GUIDELINE

A. List the ways in which engines are classified.

B. What are the names and functions of the supporting engine systems?

C. What is the purpose of the primary ignition circuit?

D. What are the advantages of water-cooled engines?

V. SUMMARY

The automotive engine is the power plant of the automobile. Systems are provided to cool, lubricate, ignite and insure fuel for proper engine performance. All these systems are necessary and inter-related.

VI. SUGGESTED TIME and SEQUENCE LISTING

30 minutes . . . Introduce and show film **ABC of Automotive Engine.**
30 minutes . . . Student comparisons of systems.
30 minutes . . . Present engine support systems.
130 minutes . . . Laboratory experiences.
140 minutes . . . Integrated curriculum concepts.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Allen, Willard A., **Know Your Car.** Chicago: American Technical Society, 1967, Second Edition.

2) Beeler, Samuel C., **Understanding Your Car,** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1967.

3) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part One . . . Engines.** Milwaukee: Bruce Publishing Company, 1964.

4) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part Two . . . The Fuel and Electrical Systems,** Milwaukee: Bruce Publishing Company, 1964.

5) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part Three . . . The Power Flow,** Milwaukee: Bruce Publishing Company, 1964.

6) Glenn, Harold T., **Exploring Power Mechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

INSTRUCTOR'S UNIT PLAN

Unit 4
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Valves, Valve Lifters and Seals**

AIM: To develop an understanding of the valve system, its components, operation, sealing, cooling and servicing.

INSTRUCTIONAL AIDS:

Loop Film - **To Remove and Replace Engine Valves,** 2298 Yonge St., Toronto 12, Canada: Moreland-Latchford Productions, Ltd. (8 mm).

Loop Film - **Engine Rebuilding Set I and Set II,** 330 W. 42nd St., New York: McGraw-Hill Book Company, Inc., Text Films Division (8 mm).

Transparencies - **#AM-5 Valve Construction** and **#AM-6 Valve Opening and Closing,** Philadelphia: DCA Educational Products, Inc.

EQUIPMENT:

8 mm loop film projector and screen, valve removing tools, feeler gauges, tappet wrenches, vacuum gauge, valve spring compressor and tester and valve grinding equipment.

PRIMARY REFERENCES:

1) Stockel, Martin W., **Auto Mechanics Fundamentals,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

2) Stockel, Martin W., **Auto Service and Repair,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1969.

3) Toboldt, William K. and Johnson, Larry, **Motor's Service Automotive Encyclopedia,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

4) Venk, Ernest A., **Automotive Fundamentals,** Chicago: American Technical Society, 1967.

I. INTRODUCTION and MOTIVATION

A. Using loop films introduce engine valve removal. Begin laboratory demonstration and lecture.

B. Proceed with supervised student practice of valve removal from laboratory engines.

II. PRESENTATION OF INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
A. Valves.	1. Intake and exhaust valves: size, dia., etc. 2. Valve types: a. Sleeve valves b. Rotary valves c. Slide valves d. Poppet valves	1. Levers and inclined planes. 2. Types of metals used to make valves.
B. Valve cooling. 1. Exhaust valve 2. Intake valve 3. Factors affecting cooling 4. Valve stem	1. Heat transfer from valve face to seat. 2. Heat transfer from valve stem to guide. 3. Proper valve grinding, seating and lapping. 4. Sodium-filled valves.	1. Heat transfer principles. 2. Heat transfer through various types of materials.
C. Valve seats.	1. Valve set angles . . . 30° and 45°. 2. One degree difference for faster seating (between valve and slat). 3. Seats are either cut into head or special hard steel inserts may be pressed into head.	1. Heat transfer from seat to block.
D. Valve operation.	1. The camshaft . . . design, lift, duration, etc. 2. The valve lifter. a. Mechanical (solid and rollor) b. Hydraulic 3. Hydraulic valve lifter operation and service 4. Valve rotation. 5. Valve springs. 6. Neoprene seals prevent oil loss. 7. Adjusting valve lash.	1. Basic principles of hydraulics (to be applied to the hydraulic valve lifter).
E. Valve Timing.	1. Camshaft determines valve lift, duration. 2. Initial valve timing with crankshaft. 3. Camshaft position. a. V-type usually above crankshaft b. In-line usually to one side of block c. Over-head camshaft design	1. Gears, levers and mechanical advantage.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Using dial indicators and feeler gauges.	1. Technical terminology of valve systems. 2. Customer relations in repair work.	1. History of valves in internal and external combustion engines.
1. Reading decimal tolerances.		
	1. Prepare one - page report on valve manufacturing and use.	
1. Formulas of pressure, force, work, etc.		
1. Arcs, circles, angles.		

II. PRESENTATION OF INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
F. Valve grinding.	1. Face 2. Margin 3. Stem 4. Seating valves 5. Valve lapping	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES

III. APPLICATION

Develop learning experiences centered around the demonstration and supervised student activities. Be sure students are exposed to the basic skills related to valve system service.

IV. EVALUATION CRITERIA GUIDELINE

A. Describe the two (2) ways in which a valve transfers heat to the head or block.

B. Explain how a hydraulic valve lifter operates.

C. Why do valves lose their sealing capabilities?

D. What are the common valve types?

V. SUMMARY

A. Valves come in a number of shapes and sizes. The most common poppet-type valve is found in the automotive engine.

B. Valves cool themselves by transferring heat to the engine head or block.

VI. SUGGESTED TIME and SEQUENCE LISTING

30 minutes . . . Lead students in laboratory demonstration and discussion following films.

220 minutes . . . Student laboratory experience . . . supervised valve removal, inspection, replacement, adjustment, etc.

90 minutes . . . Integrated curriculum concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Allen, Willard A., **Know Your Car.** Chicago: American Technical Society, 1967, Second Edition.

2) Beeler, Samuel C., **Understanding Your Car.** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1967.

3) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part One . . . Engines,** Milwaukee: Bruce Publishing Company, 1964.

4. Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part Two . . . The Fuel and Electrical Systems,** Milwaukee: Bruce Publishing Company, 1964.

5) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part Three . . . The Power Flow,** Milwaukee: Bruce Publishing Company, 1964.

6) Glenn, Harold T., **Exploring Power Mechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

INSTRUCTOR'S UNIT PLAN

Unit 5
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Crankshaft, Camshaft and Bearings**

AIM: To develop an understanding of the importance of the crankshaft and camshaft in engine operation and the requirements which bearings must meet to function as bearing surfaces.

INSTRUCTIONAL AIDS:

Loop Film - **Engine Rebuilding Set.** 330 W. 42nd St., New York: McGraw-Hill Book Company, Inc., Text Films Division (8 mm).

Film - **A Real Blue Chip Operation.** Saginaw, Mich. 48605: Central Foundry Division of General Motors (14 minutes, 16 mm, sound, color).

EQUIPMENT:

8 mm, 16 mm projectors and screen. Tools needed for crankshaft removal, plastigage, torque wrench and standard engine wrench sets, camshaft bearing remover, micrometers, rifle cleaners, puller sets and feeler gauges.

PRIMARY REFERENCES:

1) Crouse, William H., **Automotive Mechanics.** New York: McGraw-Hill Book Company, Inc., 1965, Fifth Edition.

2) Stockel, Martin W., **Auto Mechanics Fundamentals.** Homewood, Ill: The Goodheart-Willcox Company, Inc., 1968.

3) Toboldt, William K. and Johnson, Larry, **Motors' Service Automotive Encyclopedia.** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

4) Venk, Ernest A., **Automotive Fundamentals.** Chicago: American Technical Society, 1967.

I. INTRODUCTION and MOTIVATION

Show films on: removal of crankshaft, making necessary measurements, replacing bearings, measuring and final assembly of crankshaft in engine. Discuss how crankshaft converts linear motion to rotary motion.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
A. Automotive crankshaft and camshaft operation.	1. Casting, forging, and machining crankshafts. 2. Locations of cranks and counterweights. 3. Conversion of linear to rotary motion. 4. Metals often used in crankshaft. 5. Relationship of camshaft to crankshaft. 6. Camshaft timing. 7. Timing gears and chains. 8. Vibration dampeners	1. Importance of balance in crankshaft. 2. Energy loss during conversion of forces. 3. Structure of materials used in crankshafts. 4. Theories of cams. 5. Torsional vibration.
B. Bearings.	1. Types of bearings in the engine a. Sleeve b. Split or half type c. Bushing type 2. Location of bearings and their purpose. 3. Necessity of "end play" allowance in crankshaft. 4. Thrust bearings. 5. Oil holes and passages through bearings. 6. Bearing requirements.	1. Effects of thrust forces on bearings. 2. Utilizing movement to lubricate surfaces. 3. Resistance of metals to attack by acids created by gasoline and fuel combustion. 4. "Rolling friction."
C. Crank and bearing service.	1. Replace crank and camshafts. 2. Machining crank and camshafts. 3. Straighten crank and camshafts. 4. Replace bearings. 5. Shim bearings. 6. Adjust bearings. 7. Clean oil passages through bearings.	1. Use of leverage and torque on wrenches.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Precision measurements and tolerances required on crankshafts. 2. Alloy ratios in crankshaft. 3. Cam design and operation.	1. Working together in teams for more efficient service. 2. Following written procedures for crank and camshaft removal and service.	1. Foundry and forgoing industry: its scope and function as a primary industry. 2. Development of overhead cam engine.
1. Selection of correct size bearings. 2. Bearing alignment. 3. Grinding cams for increased engine performance. 4. Oil clearances in bearings.	1. Determining exact specifications and information for parts.	1. Components used in racing engines. 2. Stock cars and modified stock racing cars. Variations in engine designs.
1. Measuring with dial indicators, micrometers, and gauges. 2. Measuring crank end play.	1. Responding satisfactorily on performance test. 2. Ordering and receiving parts from suppliers. 3. Seeking advise and assistance from others.	1. Mass production of engines and its economic effects on "heavy" repair and service.

III. APPLICATION

A. Students should spend the full lab time with experiences in removing and servicing cranks, camshafts and bearings. Individuals should begin to develop proficiency in this type of mechanical work.

B. The films should be shown in the related classes, if possible.

IV. EVALUATION CRITERIA GUIDELINE

A. How are thrust bearings different from other main bearings?

B. What characteristics must bearings possess if they are to do their job correctly?

C. Will upper main bearing halves fit into lower bearing shells?

D. What is the relationship of the camshaft to the crankshaft?

E. How are the basic engine parts lubricated?

V. SUMMARY

A. The engine crankshaft converts reciprocating motion produced within engine cylinders to rotary motion in the crankshaft. Because of the stresses placed on the crankshaft, bearing perform a critical function in preventing damage to the bearing journals.

B. The camshaft is turned by the crankshaft and provides the essential valve tuning needed for proper combustion.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Show loop films on engine rebuilding.

220 minutes . . . Develop skill in servicing crank and camshafts and bearings.

80 minutes . . . Integrated curriculum concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part One . . . Engines,** Milwaukee: Bruce Publishing Company, 1964.

2) Christy, John, **How to Build Hot Rods and Race Them,** Indianapolis: Bobbs-Merrill Company, Inc., 1966.

3) DeCamp, L. Sprague, **Engines: Man's Use of Power,** New York: Affiliated Publishers, 1959.

4) Epstein, Samuel and Beryl, **All About Engines and Power,** New York: Random House, Inc., 1962.

5) Glenn, Harold T., **Exploring Power Mechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

6) Glenn, Harold T., **Power Mechanics Workbook:** based on the textbook: **Exploring Power Mechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

7) Heitner, Joseph, **Automotive Mechanics,** Princeton, N. J.: D. Van Nostrand Company, Inc., 1967.

8) Kuns, Ray F., (Rev. by Duvall, Jack J.), **Automotive Essentials,** Milwaukee: Bruce Publishing Company, 1966.

9) Mann, Martin, **How Things Work,** New York: Thomas Y. Crowell Company, 1960.

10) Roberson, Paul, **Engines**, New York: The John Day Company, 1965.

11) Ruchlis, Hyman, **The Wonder of Heat Energy**, Evanston, Ill.: Harper & Row, Publishers, El-Hi Division, 1961.

12) Schneider, Herman and Nina, **More Power to You**, New York: William R. Scott, Inc., 1958.

INSTRUCTOR'S UNIT PLAN

Unit 6
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Pistons, Rings and Oil Control**

AIM: To develop an understanding of the function of pistons and piston rings and to develop the basic skills needed to replace or service pistons and rings during engine overhaul.

INSTRUCTIONAL AIDS:

Loop Film - **Shop Assignments, Pistons and Connecting Rods.** 2298 Yonge St., Toronto 12, Canada: Moreland-Latchford Productions, Ltd. (8 mm).

Teacher-prepared lab job sheets.

Film - **Ferrous Casting Design.** Detroit: General Motors Corporation (13 minutes, 16 mm, sound, color).

Transparencies - #AM-7, **Piston and Connecting Rod Assemblies.** Philadelphia: DCA Educational Products, Inc.

EQUIPMENT:

8 mm loop film projector, 16 mm projector and screen.

Necessary tools for piston removal, piston ring compressor, torque wrench, ring groove cleaner, ring expander, feeler gauges and micrometers.
Cleaning tools and solvents.

PRIMARY REFERENCES:

1) Crouse, William H., **Automotive Mechanics.** New York: McGraw-Hill Book Company, Inc., 1965, Fifth Edition.

2) **Motor's Auto Repair Manual.** 250 W. 55th St., New York: Motor Book Department, 1968.

3) **Piston, Pin and Sleeve Technical Manual.** 8001 Pleasant Valley Rd., Cleveland, Ohio: Thompson Products Replacement Division, Thompson Ramo Woolridge, Inc.

4) Stockel, Martin, **Automechanics Fundamentals.** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

I. INTRODUCTION and MOTIVATION

A. Before class begins, arrange to have a completely disassembled engine laid out carefully on a display panel or appropriate area. Have students try to identify the engine parts and their relationships.

B. Introduce and show loop film: **Shop Assignments, Pistons and Connecting Rods.**

II. PRESENTATION OF INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Piston design.	1. Function of pistons. 2. Piston structure a. Split skirt b. T-slot c. Steel strut d. Cam ground e. Partial skirt f. Piston head shapes g. Piston pin boss 3. Combustion chamber design and its effects on the burning gases. 4. Connecting rods a. Design and function b. Rod removal c. Replacement of inserts d. Bearing shell seating e. Integral bearing adjustment f. Side clearance g. Connecting rod alignment	1. Effects of combustion temperature on piston design and construction. 2. Utilization of expansion and contraction of metals for sealing. 3. Review principles of heat transfer. 4. Combustion is rapid burning of gases. 5. Forces created by combustion. 6. Expansion-contraction coefficients for steel and aluminum.
B. Piston rings and clearance.	1. Minimum and maximum piston clearance in the cylinder. a. Skirt b. Head 2. Piston ring design and function. 3. Fitting the ring to the groove. 4. Types of rings: a. Compression b. Oil 5. Ring gap clearance and types of joints. 6. Compression ring shapes: a. Plain b. Bevel edge c. Inner groove-curved d. Inner grooved-square e. Outer groove-scraper type e. Stotted expander as a ring f. Plain with additional steel rail for scraping effect 7. Oil ring shapes: a. Slotted bevel edge b. Slotted-square edge c. Slotted-square edge with steel side rails d. Steel rail with slotted expander e. Slotted expander as a ring	1. Solid friction and rolling friction. 2. Sealing principles. 3. Pistons and ring metallurgy. 4. Converting linear to rotary motion with the crankshaft and connecting rod. 5. Lubrication principles. 6. Wearing-in or breaking-in theory.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measuring combustion temperatures and piston wear. 2. Clearances on piston pin and slots. 3. Calculating temperatures created by variations in combustion chamber design.	1. Identification of piston terminology.	1. Powerful influence of automotive lobbyists. 2. Struggle of rotary and external type combustion engine inventors to have their innovation marketed.
1. Measuring piston and ring clearances. 2. Estimating parts and labor cost for engine overhaul and rebuild. 3. Identifying tolerances.	1. Read and comprehend a variety of instruction sheets and technical data related to engine overhaul.	1. Development of automotive engine metallurgy in the industry. 2. Effects of driving habits and distances on engines. 3. Importance of piston rings in controlling pollution.

II PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
	8. Other types of pis,ons such as diesel, rotary, steam, etc.	
C. Lubrication and oil control.	1. Trace oil circuits through components (connecting rods, bearings, wrist pins, etc.). 2. Engine oils review.	1. Recommended viscosities for engine oils.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Determining hole and oil passage sizes.	1. Read several books describing how engines are constructed.	1. What the consumer should know about lubrication systems in automotive and small engines.

III. APPLICATION

Students should spend most of their laboratory time disassembling, inspecting, measuring and checking pistons, rings and cylinder walls of engines. Small lawn mower engines may be used for beginners because of their simplicity and high transfer ability.

IV. EVALUATION CRITERIA GUIDELINE

A. How do rings seal for oil losses?

B. What is meant by "blow-by"?

C. How many rings are usually used as compression rings? Oil rings?

D. Identify basic piston shapes.

E. How does cylinder design affect the combustion process?

V. SUMMARY

Pistons and piston rings receive much of the severe heat and strain of combustion within the auto engine. Pistons are of various design and made of various materials. Rings must perform several jobs: reduce friction, control compression and oil consumption. It is therefore necessary that the correct ring be installed in the correct order and with ring gaps correctly spaced.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . . Show loop film.

220 minutes . . . Demonstration and student practice of piston removal, ring removal, ring replacement, piston and replacement.

80 minutes . . . Integrated curriculum concepts.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Basic Ball Bearing Types (A245),** Bristol, Conn.: New Departure-Hyatt Bearing Company.

2) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto-Mechanics Standard Practice Job Sheets . . . Part One . . . Engines,** Milwaukee: Bruce Publishing Company, 1964.

3) Ruchlis, Hyman, **The Wonder of Heat Energy,** Evanston, Ill.: Harper & Row, Publishers, El-Hi Division, 1961.

4) **Seals, Separators, Lubricants (A246),** Bristol, Conn.: New Departure-Hyatt Bearings Company.

5) **ABC of Anti-Friction Bearings (AFB), The,** Bristol, Conn.: New Departure-Hyatt Bearings Company.

6) Zim, Herbert S., **What's Inside of Engines,** New York: William Morrow & Company, Inc., 1953.

INSTRUCTOR'S UNIT PLAN

Unit 7
Lesson 1
Time . . . . . 6 hours

CLUSTER:	TRANSPORTATION
DIVISION:	AUTOMOTIVE SERVICES II
SUBJECT:	**Lubrication System**
AIM:	To develop an understanding of the function and operation of the automotive engine lubrication system and develop basic mechanical skills in servicing the system and its components.

INSTRUCTIONAL AIDS:

Film - **Oil Films in Action**, Detroit: General Motors Film Library, General Motors Building (16 minutes, 16 mm, sound).

Film - **Where Mileage Begins**, Detroit: General Motors Corporation Film Library (26 minutes 16 mm, sound).

Slides - A series of teacher-made slides showing specific and critical points in the lube system. Should also show chief service points.

Transparencies - **#AM-10. Engine Lubrication**, Philadelphia: DCA Educational Products, Inc.

EQUIPMENT:

16 mm film projector, 35 mm slide projector and screen, rotary and gear type oil pumps, filters, different types of oils in quart cans and operating engines.

PRIMARY REFERENCES:

1) Crouse, William H., **Automotive Fuel, Lubricating and Cooling Systems**, New York: McGraw-Hill Book Company, Inc., 1959.

2) Crouse, William H., **Automotive Mechanics**, New York: McGraw-Hill Book Company, Inc., 1965.

3) **Shellubrication Specification Guide Book**, Shell Oil Company, 1969 & 1970.

4) Toboldt, William K. and Johnson, Larry, **Motor Service's Automotive Encyclopedia**, Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

I. INTRODUCTION and MOTIVATION

A. Instructor can set up equipment for a demonstration on some of the common services done on the lubrication system. Have students time instructor on three different services and compute how much he would have earned in a garage. Compare this time with the **Flat Rate Manual Guidelines**. Follow with discussion on types of skills needed by mechanics.
B. Show film: **Oil Films in Action** and discuss lubrication theories.

II. PRESENTATION OF INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Engine lubrication systems.	1. Purpose of the system. 2. Types of systems. a. Splash b. Pressure c. Combination splash and pressure 3. Flow of oil in the system. 4. Ventilation in the system.	1. Oils as a lubricant and a coolant. 2. Use of gravity in splash system. 3. Flow of oil through oil pump. 4. Chemical analysis of oil. 5. Oil additives. 6. Theory of ventilating lube systems.
B. System components.	1. Oil pumps. a. Gear type b. Rotary type 2. Filters. a. Full flow b. By pass 3. Lines and passages. 4. Dash indicator or gauge. 5. Pressure regulator valve. 6. Oil strainer. 7. Oil level indicator.	1. Characteristics of materials selected for components. 2. Variations in flow through gear and rotor pumps. 3. Maintaining pressure in the system. 4. Filter materials.
C. Engine oils.	1. Function of oils. a. Seals b. Lubricates c. Cools d. Cleans e. Cushions f. Prevents corrosion and rust. 2. Classifications of engine oils. a. ML, MM, MS Service b. Viscosity rating c. Multi-viscosity oils d. Detergent oils	1. How heat affects friction-reducing properties. 2. Reduction of friction by oils. 3. Oil cohesiveness. 4. Oil adhesiveness. 5. Causes of "oil breakdown." 6. Testing oils. 7. Various grades of oils. 8. Chemical structure of oil additives. 9. Viscosity levels and measurement.
D. Bearing clearances.	1. The relationships between low oil pressure and bearing wear.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. System capacities. 2. Size and shape of oil lines and passages. 3. Efficiency of splash vs pressure system in long run.	1. Understanding lube charts showing diagrams of oil flow in system. 2. Verbalize flow of oil in system.	1. Development of lubricants. 2. Use of friction in transportation vehicles. 3. Scope of petroleum industries. 4. Off-shore drilling, advantages and disadvantages.
1. Fluid pressure measurement. 2. Check tolerances in oil pumps. 3. Testing pressure relief valve. 4. Liquid volume measurements.	1. Explain concepts of wet friction, dry friction, solid friction and rolling friction.	1. Research in the American Petroleum Institute. 2. Geographic location of tank farms. 3. Pipe line industries. 4. Pipe line network in the U. S.
1. Determine percentage of combustion heat dissipated in lubrication system. 2. Determining viscosity ratings. 3. Figuring cost of oils.	1. Explain oil ratings to customers. 2. Recommend type of oil for customer. 3. Advertising techniques used by oil industries.	1. Production of oil. 2. Marketing and retailing sales in oil companies.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
E. Servicing the lubrication system. (Emphasis on skill development)	1. Change engine oil. 2. Replace filter. 3. Clean oil strainer. 4. Repair or replace oil pump. 5. Clean out oil lines and passage. 6. Troubleshoot (and replace if necessary) dash indicator. 7. Test and/or replace pressure relief valve. 8. Flush crankcase and oil circuits. 9. Clean or replace oil filler pipe air cleaner. 10. Inspect engine for oil leaks around gaskets.	1. Straight flushing and reverse flushing concepts. 2. Test equipment for testing pressure relief valve. 3. Selection of chemicals for flushing and cleaning crankcase. 4. Gasket materials and sealing principles.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Locating correct part number. 2. Matching thread sizes on drain plugs, screw-on type filters, etc.	1. Obtaining correct replacement part from parts department. 2. Encouraging mechanics to attend short training schools and clinics to keep up to date with new developments.	1. Levels of manipulative skills needed for working on the lubrication system. 2. Salary ranges and supply-demand of mechanics.

III. APPLICATION

A. Students should concentrate on laboratory experiences which will help them develop apprentice level skills in servicing the lubrication system.

B. Students may work in pairs on an engine and go through a set of listed checks and services prepared by the instructor.

IV. EVALUATION CRITERIA GUIDELINE

A. Have students explain the purpose of lubrication.

B. Describe types of friction.

C. What are the oil classifications designated by A. P. I.?

D. What does the S. A. E. number mean?

E. Describe and explain four functions of oil in the lubrication system.

V. SUMMARY

A. Review briefly the purpose and function of the lubrication system. Recall the most common service needed and those which call for major repair or replacement of parts.

B. Students should develop proficiency in servicing the system to the point where they compare favorably with the recommended time in the **Flat Rate Manual.**

VI. SUGGESTED TIME and SEQUENCE LISTING

45 minutes . . . Show films: **Where Mileage Begins,** and **Oil Films in Action** Discuss films.

180 minutes . . . Concentrated laboratory work on engines.

115 minutes . . . Related concepts in science, math, communications and social studies.

20 minutes . . . Summary and review.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **AC Positive Crankcase Ventilation System Manual.** Milwaukee: AC Electronics Division of General Motors Corporation (Booklet).

2) Allen, Willard A., **Know Your Car,** Chicago: American Technical Society, 1968.

3) Beeler, Samuel C., **Understanding Your Car,** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1967.

4) Crouse, William H., **Automotive Mechanics,** New York: McGraw-Hill Book Company, Inc., 1965.

5) **Engine Protection Through Lube and Fuel Filtration,** Milwaukee: AC Electronic Division of General Motors Corporation (Booklet).

6) Kuns, R. and Duvall, J., **Automotive Essentials,** Milwaukee: Bruce Publishing company, 1966.

7) **The ABC of Anti-Friction Bearings (AFB),** Bristol, Conn.: New Departure-Hyatt Bearing Division of General Motors Corporation (Booklet).

8) **The Chemistry of Petroleum,** New York: American Petroleum Institute (Booklet).

9) **The Physics of Petroleum,** New York: American Petroleum Institute (Booklet).

INSTRUCTOR'S UNIT PLAN

Unit 8
Lesson 1
Time . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Cooling System Service**

AIM: To develop an understanding of the function, operation and servicing of an automotive cooling system.

INSTRUCTIONAL AIDS:

Cutaway of water pump, radiator.

Transpariences - **The Cooling System.** Philadelphia: DCA Educational Products, Inc., #AM-11, AM-12, AM-13, AM-33 and AM-34. 1

Booklets - **Harrison Heat Exchangers.** Lockport, New York: Harrison Radiator Division.

Chart - **Automobile Engine Cooling System.** New York: AFP-1511, National Carbon Company, 30 E. 42nd St.

EQUIPMENT:

Overhead projector and screen, water pump, radiator, thermostat, hoses, gaskets, water temperature gauge, anti-freeze tester and radiator flushing equipment. Automobile cooling systems (mock-ups or real).

PRIMARY REFERENCES:

1) **Chassis Service Manual.** Detroit: Chevrolet Motor Division, General Motors Corporation, 1970.

2) Toboldt, William K. and Purvis, Jud, **Motor Service's Automotive Encyclopedia,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1965.

I. INTRODUCTION and MOTIVATION

A. Proper care of the cooling system can improve an engine's performance. Customer relationships and sales will also improve if services are offered.

B. In order to offer such services, the cooling system should be well known.

II. PRESENTATION OF INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
A. Radiators.	1. Designed to dissipate heat. 2. Has water passages and air passages. 3. Two types included: 1) tube and fin, 2) ribbon cellular or honeycomb. 4. Coolant flows from engine into the top of the radiator and out the bottom back into the engine. 5. Parts of radiator include shell, core, upper and lower tanks, inlet, outlet, drain cock, fan shroud. 6. Usually made of brass, copper, or aluminum. 7. Expansion tanks provide additional room. 8. Cooling of transmission fluid by radiator.	1. Ability of different metals to dissipate heat. 2. Expansion of coolant when heated. 3. Use of coolant additives to prevent corrosion.
B. Water pumps.	1. Used to circulate coolant. 2. Most common type employs an impeller. 3. Located on the front of the engine block. 4. Housing is usually cast iron or aluminum. 5. Has inlet, outlet, impeller, bearings, seal. 6. Fan is attached to its shaft. 7. Works upon principle of centrifugal force. 8. It is driven by a vee-belt and pulley from the crankshaft damper pulley.	1. Other types of pumps. 2. Efficiency of the impeller pump. 3. Centrifugal and centripetal forces. 4. Pulleys, mechanical advantage.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measuring radiator capacity. 2. Computing antifreeze-water ratios. 3. Measuring and computing pressure. 4. Measuring heat dissipation ability of different metals.	1. Use of proper terminology for ordering parts. 2. Explaining importance of cooling system care to customer. 3. Relating importance of antifreeze use for protection and lubrication.	1. Changes in radiators for higher speed cars. 2. Use of aluminum for more components. 3. Development of coolants and additives.
1. Measuring and computing pump volume. 2. Computing speed variations as related to pulley sizes.	1. Writing for additional information.	1. Other uses for water pumps. 2. Changes in pump design. 3. Economic effects upon materials used.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
C. Drive belts and radiator pressure caps.	1. Drive belts operate the fan, the electrical system, power steering pump, and air conditioning compressor. 2. Faulty belts cause system to fail and may result in damage to the system. 3. Keep belts free of grease or oil; worn belts should be replaced; cracks shorten the life of a belt; belt should not ride in the bottom of the pulley. 4. Tight belt adjustment wears bearings, too loose causes squeals. 5. Pressure caps prevent water boiling and evaproation. 6. Caps have vacuum valve, overflow pipe, and blowoff valve. 7. Inspect caps for worn seals and corrosion.	1. Drive belt construction and material. 2. Effect of grease and oil upon drive belt material. 3. Temperature-pressure relationships. 4. Principles of operation of radiator cap.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measuring drive belt sizes for specific uses. 2. Testing pressure caps and reading pressure gauges.	1. Reading to determine compatibility of materials with grease and oil. 2. Reading manuals for specifications concerning pressure caps.	1. Pressure relief valves compared to radiator caps as related to safety.

III. APPLICATION

A. Experiences involving cooling system maintenance should be obtained by students.

B. Students should work on and troubleshoot cooling systems.

IV. EVALUATION CRITERIA GUIDELINE

A. What are some possible causes of a squealing sound in the cooling system?

B. How could a faulty radiator cap cause overheating?

C. Lack of heater temperature would be caused by what component?

V. SUMMARY

The radiator is the prime device where the water can shed its heat. This water must be returned to the engine to cool it. The water pump serves the purpose for circulation. The drive belts are the "backbone" of the cooling system because they provide (transfer) the power.

VI. SUGGESTED TIME and SEQUENCE LISTING

200 minutes . . . Presentation and activity.

140 minutes . . . Related concepts.

20 minutes . . . Summary and review.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Crouse, William H., **Automotive Mechanics**, New York: McGraw-Hill Book Company, Inc., 1965.

2) Kuns, Ray F., **Automotive Essentials**, Milwaukee: Bruce Publishing Company, 1966.

3) **Serviceman's Manual on the Automotive Cooling System**, Wilmington, Del.: E. I. du Pont de Nemours and Company, Inc., 1951.

INSTRUCTOR'S UNIT PLAN

Unit . . . 7 9
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Fuel System**

AIM: To develop an understanding of the operation of the automotive fuel system and how to service its component parts.

INSTRUCTIONAL AIDS:

Transparencies - **The Fuel System, Principles of Operation,** Course 95001, Detroit: Ford Motor Company.

Transparencies - **#AM-Fuel System, AM-2, AM-3, AM-4** Carburetor Circuits, Philadelphia: DCA Educational Products, Inc.

Job Sheets - Teacher-prepared job sheets for disassembly and reassembly of demonstration carburetors.

EQUIPMENT:

Overhead projector and screen, fuel ignition chamber, fuel and DC electrical power supply, Burought's carburetor service tool kit and 1, 2 and 4 barrel carburetors, and hand-operated spray gun for venturi demonstration.

PRIMARY REFERENCES:

1) **Carburetor Fundamentals and Facts, #70-8,** Detroit: Chrysler Motors Corporation (Booklet).

2) Stockel, Martin W., **Auto Mechanics Fundamentals,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1969

3) Stockel, Martin W., **Auto Service and Repair,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1969.

4) **Student Technical Bulletins on Fuel System,** 959 Crenshaw Blvd., Los Angeles: Alondra, Inc.

I. INTRODUCTION and MOTIVATION

A. Review fuel system. Elicit student questions on operation and components.

B. Proceed with demonstration utilizing transparencies and sample component parts.

II. PRESENTATION OF INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Function of the fuel system.	1. Provides engine with combustible mixture of air and fuel.	1. Study of fuels. 2. How gasoline is processed from petroleum.
B. Components of the fuel system. 1. Fuel tank 2. Fuel lines 3. Fuel pump 4. Fuel filter 5. Carburator 6. Air cleaner	1. Fuel tank as a vented reservoir for gasoline. 2. Fuel lines as transporting devices for the gasoline between various components. 3. Fuel pump forces to carburetor. a. Mechanical b. Electrical 4. Fuel filter removes froeign material from fuel. 5. Types of filters: a. Ceramic b. Paper c. Metal 6. The carburetor as a device for mixing air and fuel in correct ratios for operation of the engine. a. Downdraft b. Side draft c. Single or multi-barrels 7. Carburetor circuits. a. Choke b. Low speed c. Idle d. High speed e. Power f. Float 8. Air cleaner as a filter to protect carburetor and engine. a. Dry replaceable b. Oil-bath type	1. Principles of pumps. 2. Venturi principles. 3. Atomizing principles. 4. Air-fuel ratio affect combustion. 5. Leaded and non-leaded fuels.
C. Fuel injection systems.	1. Principles of fuel injection. 2. Advantages and disadvantages.	1. Pressure systems for fuel injection.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Study of ratio as applied to fuels, combustion, etc. 2. Study of proportions by volume and weight.	1. Advertising techniques of the petroleum industry.	1. Historical study of the preparation of fuels. 2. Effects of the petroleum industry on our society.
1. Carburetor jet sizes and clearances.	1. Understanding technical vocabulary related to fuel systems and petroleum production. 2. Develop information chart showing how gasoline is produced.	1. General vs. specialized mechanics.
1. Measuring injection orifices and pressure.	1. Informing the public about efficiency of fuel injection.	1. Fuel injection, trend or fad?

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
D. Servicing the fuel system.	1. Checking fuel tank for clogged vent or leaks. 2. Checking fuel lines for break or obstruction. 3. Testing fuel pump volume and pressure. 4. Checking and replacing fuel filter. 5. Checking carburetor operations. 6. Checking and adjusting individual carburetor circuits (float, idle, high speed, accelerator pump, etc.). 7. Service of air cleaning system. 8. Servicing fuel injection pumps. 9. Testing and replacing injection components.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Cost concepts of fuel system service and repair.	1. Talking to people (customers) about fuel system safety.	1. What is being done by the petroleum industry to cure pollution?

III. APPLICATION

A. From classroom sessions, have students in a laboratory situation dismantle, locate and identify various components and reassemble simple carburetors. Use job sheet (teacher-prepared) to assist students.

B. Have students do a programmed unit by Ford Motor Company entitled: **The Fuel System, Principles of Operation.**

IV. EVALUATION CRITERIA GUIDELINE

A. Trace the route of the fuel from the fuel tank to the engine.

B. What material in the air is responsible for supporting the burning of the fuel?

C. Explain several methods of checking the operation of the carburetor.

V. SUMMARY

The fuel system provides the power plant with a combustible mixture of air and gasoline. Scientific background knowledge is necessary to make valid evaluations of fuel system malfunctions.

VI. SUGGESTED TIME and SEQUENCE LISTING

60 minutes . . . Showing transparencies, directing lectures.

60 minutes . . . Laboratory practice.

120 minutes . . . Programmed unit . . . **Fuel System.**

30minutes . . . Science concepts . . . principles of combustion, heat generation, etc.

90 minutes . . . Other related curriculum concepts.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Bostwick, Harold S., Green, Lawrence and Yergey, William H., **Auto Mechanics Standard Practice Job Sheets . . . Part Two . . . Fuel and Electrical Systems**, Milwaukee, Wis.: Bruce Publishing Company, 1964.

2) Crouse, William H., **Automotive Fuel, Lubricating and Cooling Systems**, New York: McGraw-Hill Book Company, Inc., 1959.

INSTRUCTOR'S UNIT PLAN

Unit 10
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Ignition System**

AIM: To develop an understanding of the function and operation of the ignition system components and how to service these components.

INSTRUCTIONAL AIDS:

Film - **Ignition and Spark Plugs,** 900 Upton Avenue, Toledo, Ohio: Champion Spark Plug Company, Film Department (19 minutes, 16 mm).

Loop Film - **Installing Spark Plug Wire Terminals,** 1212 Avenue of the Americas, New York 10036: Modern Learning Aids (8 mm).

Loop Film - **Replacing Ignition Points,** New York: Modern Learning Aids (8 mm).

Loop Film - **Spark Plug Service,** New York: Modern Learning Aids (8 mm).
Loop Film - **Timing an Engine,** New York: Modern Learning Aids (8 mm).

Transparencies - **AM-8 Ignition System Firing** and **AM-9 Spark Plugs,** Philadelphia: DCA Educational Products, Inc.

EQUIPMENT:

16 mm projector, 8 mm loop film projector, overhead projector, screen, ignition system tools, test equipment, distributor tester, spark plug cleaner and tester, electronic engine analyzer, tack-dwell meters, feeler and wire gauges.

Demonstration engines on stands or automobiles for student practice.

PRIMARY REFERENCES:

1) Frazee, Irving, et al., **Automotive Electric Systems,** Chicago: American Technical Society, 1956.

2) **Fundamentals of Electricity** (Course 13000.1 Programed Text), Detroit: Ford Division, Ford Motor Company.

3) Stockel, Martin, **Auto Mechanics Fundamentals,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

4) Toboldt, William and Johnson, Larry, **Motor's Service Automotive Encyclopedia,** Homewood, Ill.: The Goodheart-Willcox Company, 1965.

I. INTRODUCTION and MOTIVATION

Introduce and show film, **Ignition and Spark Plugs.** Follow with discussion of ignition system design and service.

II. PRESENTATION OF INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
A. Function of the ignition system.	1. Function of the primary circuit. 2. Function of the secondary circuit. 3. Transistorized ignition systems.	1. Theory of electricity. 2. Transistors. 3. Solid state.
B. Primary ignition system components.	1. The battery as a source of power for the ignition system. 2. Ignition switch as control. 3. Ignition coil as a transformer (step-up). 4. Distributor including breaker points, condenser and spark advance mechanism.	1. Chemical action into electricity (battery).
C. Secondary ignition system components.	1. Ignition coil secondary windings. 2. Distributor including rotor and high tension terminals. 3. High tension iginition wires. a. Solid b. Carbon 4. Spark plugs as air-fuel igniters.	1. Principles of transformers (DC type). 2. Characteristics of high voltage.
D. Servicing the ignition system.	1. Checking the function and operation of each component. 2. Replacing and/or adjusting breaker points and dwell. 3. Checking and adjusting ignition timing. 4. "Dead" timing non-running engine. 5. Checking and adjusting mechanical and vacuum advance mechanisms. 6. Distributor service. 7. Replace wires and terminals. 8. Clean, service, test, or replace spark plugs. 9. Troubleshoot ignition system electronically.	1. Using scientific knowlege to evaluate ignition system problems. 2. Problem solving technique.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Study of Ohm's Law. 2. Problems in automotive electrical circuits.	1. Prepare an oral report on any phase of the ignition system. 2. Alert public to economic advantages of transistorized ignition systems.	1. Study of the development of spark plugs. 2. Impact of transistorized ignition systems of auto markets.
1. Concepts of ratios . . . applying to step-up transformers.		1. Use of transformers for cross country high tension power lines.
1. Angles and degrees. 2. Cost concepts of ignition tune-up work.	1. Discuss advertising techniques which can be used by the local serviceman.	1. Development of magneto ignition and spark ignition systems.

III. APPLICATION

A. Using loop films, discuss components: their function and service.

B. Demonstrate actual service techniques of:
1. Point replacement and adjustment.
2. Condenser replacement.
3. Checking and servicing spark plugs.
4. Timing the engine.
5. "Dead" timing engine.
6. Troubleshooting techniques of ignition service.

C. Have students practice on demonstration engines or actual automobile.

IV. EVALUATION CRITERIA GUIDELINE

A. How does the voltage in the ignition system change from 6 or 12 volts in the primary circuit to 15,000 to 20,000 volts in the secondary circuit?

B. Why must an engine and its ignition system be timed?

V. SUMMARY

The ignition system is actually two separate systems: the primary and secondary. A thorough knowledge of these systems is necessary for effective troubleshooting and servicing the circuits.

VI. SUGGESTED TIME and SEQUENCE LISTING

220 minutes . . .	Show film and lecture and discuss with film loops. Laboratory demonstrations and student experiences.
40 minutes . . .	Finish **Fundamentals of Electricity** program.
80 minutes . . .	Integrated curriculum concepts.
20 minutes . . .	Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Better Ignition**, DR-5141, Anderson, Ind.: Delco-Remy Division, General Motors Corporation (free in quantity).

2) Crouse, William H., **Automotive Electrical Equipment**, New York: McGraw-Hill Book Company, Inc., 1966, Sixth Edition.

3) **20,000 Volts Under the Hood**, Anderson, Ind.: Delco-Remy Division, General Motors Corporation (booklet).

INSTRUCTOR'S UNIT PLAN

Unit 11
Time . . . . . . 6 hours
Lesson 1

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Starting System**

AIM: To develop an understanding and skill in the operation and service of the automotive starting system.

INSTRUCTIONAL AIDS:

Filmstrip - **The Cranking Circuit DR-9025-K.** Anderson, Ind.: Delco-Remy Division of General Motors Corporation (12 minutes, 35 mm, sound, color).

Transparencies - **Starting System,** #636, 2501 Hudson Road, St. Paul, Minn.: Minnesota Mining and Manufacturing Business Products.

Filmstrip - **An Introduction to the Automotive Electrical System, DR 9010 K.** Anderson, Ind.: Delco-Remy Division of General Motors Corporation (15 minutes, 35 mm, sound, color).

Wall Charts - **Section A - Fundamentals of Electricity and Magnetism; Section B - Storage Batteries;** and **Section C - Cranking Motors and Series Parallel Swithches,** Anderson, Ind.: Delco-Remy Division of General Motors Corp.

EQUIPMENT:

Overhead projector, 35 mm slide projector and screen. Sample starting motors, solenoids, ignition switches, batteries, battery starter tester, mechanical tachometer, jumper cables, ohmmeter, mica-cutter, growler and feeler gauges.

PRIMARY REFERENCES:

1) Allen, Willard A., **Know Your Car,** Chicago: American Technical Society, 1967, Second Edition.

2) Crouse, William H., **Automotive Electrical Equipment,** New York: McGraw-Hill Book Company, Inc., 1966, Sixth Edition.

3) Crouse, William H., **Automotive Mechanics,** New York: McGraw-Hill Book Company, Inc., 1965 Fifth Edition.

4) Frazee, I. and Bedell, E., **Automotive Electrical Systems,** Chicago: American Technical Society, 1967.

5) Glenn, Harold T., **Automechanics.** Peoria, Ill.: Charles A. Bennett Company, Inc., 1962.

6) Kuns, Ray F. (Rev. by Duvall, Jack J.), **Automotive Essentials,** Milwaukee: Bruce Publishing Company, 1966.

7) **Cranking Circuit, The,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Booklet).

I. INTRODUCTION and MOTIVATION

A. Introduce and show the filmstrip: **The Cranking Circuit.** Have students list components shown in the film. Have them sketch the relationship of the components in a diagram and explain how each one functions.

B. Demonstrate selected cranking system services pointing out the level of skill needed for performing each job.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Function of the starting system.	1. An auxiliary motor starts the engine rotating at operational speeds. 2. Components: a. Starter b. Solenoid c. Switch d. Battery e. Wires 3. Trace flow of energy through components. 4. Types of cranking motor drives. a. Inertia type b. Over-running clutch type 5. Basic principles of electric motors. 6. Electric motor construction.	1. Solenoid operation. 2. Centrifugal force. 3. Converting electrical energy to mechanical energy. 4. Generation of magnetic fields and electromagnets. 5. Movement of electrons in circuit when energized. 6. Battery operations. 7. Electrical forces' which cause the armature to rotate. 8. Speed and torque characteristics.
B. Servicing the starting system. 1. Remove starting motor. 2. Test and repair armature. 3. Test and repair field coils. 4. Preassembly check on starting motor. 5. Adjustments. 6. Starting motor test.	1. Check all wires and connections. Test starting motor for operation. 2. Remove and disassemble starting motor. Clean all parts carefully. 3. Check armature for visual problems. Check bearing surfaces for wear. 4. Turn down commutator and armature shaft. Undercut insulation grooves (if recommended). 5. Check bushings in commutator and end plate. 6. Test armature for ground and/or open circuit. 7. Test fields for ground and/or open circuit. 8. Replace field coils. 9. Check commutator end plate. 10. Starter brushes (clean or replace). 11. Starter drive housing or end plate. 12. Starter drive. 13. Reassemble starting motor.	1. Review theory of circuitry. 2. Characteristics of direct current 3. Parts cleaning chemical characteristics and precautions that should be taken. 4. Insulation materials that can withstand heat. 5. Review magnetism and electromagnetic force. 6. Similarities between a generator and a starting motor.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measuring volts and amps. 2. Selecting size of wires for conducting electricity. a. From battery to solenoid b. Remainder of circuit. 3. Starter motor drive gear ratio with flywheel teeth. 4. Measuring speed and torque of armature.	1. Terminology related to starting system. 2. Read electrical schematic diagrams.	1. History of means of starting different types of engines.
1. Metric scale used on foreign-made tools. 2. Tool sizes and variations for special operations. 3. Specifications for starting motor tests. 4. Compare economics of repairing starting motor with: a. Rebuilt motor. b. New motor. 5. Ratio of lines of force being cut by a conductor and voltage generated.	1. Convey to machinist what is to be done on the commutator. 2. Suggest to customer a course of action with regard to repair or purchase rebuilt starting motor. 3. Keep starting motor terminology clear. Similarties with generator nomenclature.	1. Apparent need for automotive industry to resort to replacement parts rather than depend on mechanics to rebuild parts.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
	14. Over-running clutch pinion clearance. 15. Alignment of motor on mount. 16. No-load test. 17. Stall-torque test. 18. Low speed, low torque, and high current draw. 19. Low no-speed, low torque, and low current draw. 20. High no-load speed, low torque, high current draw. 21. Failure to operate because of: a. High current draw b. Low current draw.	
C. Starting motor switch service.	1. Types of switches a. Magnetic b. Solenoid c. Vacuum d. Neutral safety switch 2. Test switches for mechanical operation and electrical connections. 3. Test for ground or shorts.	1. Importance of cleanliness when working around electrical components.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Determining switch capacities.	1. Designating types of switches by proper name. 2. Keeping the customer's car clean during repair work.	1. Switches and electrical controls with built-in safety features.

III. APPLICATION

Students should be shown the filmstrip: **The Cranking Circuit**, followed by brief demonstrations by the instructor on starting motor servicing. The remainder of the lab period should be devoted to developing repair skills on the starting system. It is recommended that the remaining instructional aids be prepared for students to review independently as the need arises.

IV. EVALUATION CRITERIA GUIDELINE

A. Name the components of the cranking system.

B. What are the arguments for and against repairing, replacing with new or replacing with rebuilt starting motor?

C. What safety precautions need be observed while working on the starting system?

D. What is the difference between a starting motor and a generator?

E. Observation and assistance with student skill development.

V. SUMMARY

A. Review function and components of starting system pointing out new terms.

B. Particular attention needs to be given to familiarity with electronic test meters and equipment which can save much time on the service end. Troubleshooting techniques should be reviewed and emphasized.

VI. SUGGESTED TIME and SEQUENCE LISTING

15 minutes . . . Show film on **The Cranking Circuit** and lead into instructor's demonstrations.

165 minutes . . . Concentrated lab experiences to develop skills in servicing and maintaining starting system components.

160 minutes . . . Related study in science, math, communications and social studies.

20 minutes . . . Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Basic Automotive Electricity**, Service Department, Ford Division, Ford Motor Company, Dearborn, Michigan (Free on request).

2) Bozarth, R. M. "Magnetism." **Encyclopaedia Britannica**, 14th Edition, Volume 14, pp. 636-667.

3) **Cranking Motors and Series Parallel Switches #5133C**, Delco-Remy Training Chart Manual, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

4) **Cranking Motors and Series Parallel Switches**, DR-5133C, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

5) **Electrical Fundamentals**, P. O. Box 1919, Detroit: Educational Services, Department of Public Relations, Chrysler Corporation.

6) **Fundamentals of Electricity and Magnetism**, DR-5133A, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

7) **Introduction to Automotive Electrical System**, DR-9010, Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Free on request in quantities up to fifty).

8) **Periodic Maintenance and Circuit Checks, DR-5221**, Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Booklet).

9) **Serving Homes, Industry and Transportation**, Dayton, Ohio: Delco Products Division of General Motors Corporation (Booklet).

10) **The Cranking Circuit**, Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Booklet).

INSTRUCTOR'S UNIT PLAN

Unit 12
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Charging and Regulating System**

AIM: To understand the operation and function of the charging and regulating circuits and how to service the component parts.

INSTRUCTIONAL AIDS:

Mock ups - Charging and regulating systems.

Chart - **Delcotron Generator and the Charging System**, Section M; **Double Contact Regulators**, Section R, Detroit: Delco-Remy Division General Motors Corporation.

Filmstrip - **Regulation and the Charging Circuit**, #DR-9015K, Detroit: Delco-Remy Division, General Motors Corporation.

EQUIPMENT:

Filmstrip projector and screen. Automobile charging circuits for student use, engine analyzer, alternator-generator tester, growler, ohmmeter, regulator feeler gauge kit, diode heat sinks and removers and alternator-regulator testing harness.

PRIMARY REFERENCES:

1) **Delcotron Generator and the Charging Circuit**, Anderson, Ind.: Delco-Remy Division of General Motors Corporation, 1963.

2) **The Crarging System Simplified**, Bulletin #2, Chicago: C. E. Niehoff and Co., 1968.

I. INTRODUCTION and MOTIVATION

The charging system is one of the most important systems of the automobile. It is the system for re-energizing the battery which is used for starting, running, lights and accessories. An understanding of this system will enable the serviceman to build his reputation and profits.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Electrical fundamentals.	1. Electricity is a flow of electrons through a conductor when there is a shortage of electrons at one end and a surplus at the other. 2. Atoms are made up of neutrons, protons and electrons. The electrons are what move and causes current flow. 3. The preassure that causes current to flow is *voltage;* the amount of current flowing is *amperage;* the force against flow is *resistance.* 4. In order to have current flow, a complete circuit must be provided. Series, series parallel, and parallel circuits are used in automobiles. 5. In magnetism, like poles repel, unlike attract. Current flow in a conductor creates a magnetic field around it.	1. Electron theory. 2. Resistors, capacitors, condensers, coils. 3. Capacitive discharge ignition. 4. Armature and field windings. 5. Inductance and induced current.
B. The Battery.	1. An electrochemical device that has positive and negative plates in an electrolyte. Electrons are stored on these plates when charged. 2. May be recharged by passing current through it. 3. Hydrometers are used to check the charge. 4. Battery is source of power for starting and is recharged by generator (6v or 12v batteries used).	1. Electroplating. 2. Specific gravity and how it indicates charge. 3. Storage battery, dry cell battery in comparison.
C. Generators.	1. Supply electrical needs of car and battery. 2. Both AC and DC generators are used. 3. Drive belt turns generator.	1. Alternating current and direct current applications.
D. Regulators.	1. Device used to controls current and voltage output of generator. 2. Keeps battery from overcharging and from discharging when engine is stopped. 3. Contains relays to make and break circuits.	1. Magnetic coils, bimetallic strips. 2. Chemical investigation of what happens during charging.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Ohm's Law. 2. Formulas concerning electricity. 3. Measuring charge using fine instruments. 4. Valence numbers, atomic numbers.	1. Writing to describe atomic structures. 2. Use of terms in discussions. 3. Use of electricity for communication purposes.	1. Development of atomic energy. 2. Impact of electricity upon society. 3. Generation of electricity on a large scale. 4. State regulations concerning electrical components.
1. Computing chemical equations. 2. Computing specific gravity.	1. Use of batteries for telephone switchboards.	1. Use of batteries to power an electric car. 2. Production of storage batteries.
1. Voltage and amperage specifications.	1. Drawing schematic circuits.	1. Large power production generators at hydroelectric plants.
1. Figuring circuit values, resistance, etc.	1. Advertising services for business promotion.	

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
E. Safety in handling battery acid.	1. Electrolyte is dangerous to skin and clothing. 2. Wash area well with water and neutralize with baking soda. 3. Never expose batteries to sparks especially when charging because of possible explosion. 4. Selection of correct ampere charging rate.	1. Acid and acid solutions. 2. Acids and bases. 3. Electrolysis of water. 4. Production of gases through electrolysis.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Ratios of mixing solution strengths. 2. Safe battery charging rates.	1. Relating of safety measures to new employees.	1. Production of battery acid.

III. APPLICATION

A. Students should become involved in work experiences concerned with the charging system.

B. Tests can be conducted and troubleshooting should be practiced.

IV. EVALUATION CRITERIA GUIDELINE

A. What would cause the battery to discharge while the engine is stopped?

B. Bad generator bearings may be caused by what?

C. An overcharged battery would indicate failure of what unit?

V. SUMMARY

The charging and regulating system is a common area of automotive problems. Knowledge to service the system is important when building a business. One experienced in this area would profit greatly in automotive servicing.

VI. SUGGESTED TIME and SEQUENCE LISTING

190 minutes . . . Presentation and activity.

150 minutes . . . Related concepts.

20 minutes . . . Summary and review.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Bulletins #1, 3, 6, 7, 10, 11, 12, 16, 22,** Chicago: C. E. Niehoff and Company, 1968, (all deal with alternators, regulators, test equipment).

2) **Fundamentals of Delcotron Generators,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation, 1966.

3) **Heavy Duty Generator Regulators, Section I and II,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation, 1951 and 1952.

4) **Periodic Maintenance and Circuit Checks,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation, 1964.

5) **Service Tips,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation, #60A-200 Sec. B., 1961.

6) **Two Unit Regulators,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation, #IR-262, 1965.

INSTRUCTOR'S UNIT PLAN

Unit 13
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Electrical System**

AIM: To develop a basic understanding of the fundamentals of electricity, and servicing procedures on the battery, lighting and accessory systems of the automobile.

INSTRUCTIONAL AIDS:

Filmstrip - **Electric Current Principles . . .** #10001, 330 W. 42nd St., New York: McGraw-Hill Book Company, Inc., Text Films Division (35 mm).

Filmstrip - **Electric Current Measurement . . .** #10002, 330 W. 42nd St., New York: McGraw-Hill Book Company, Inc., Text Films Division (35 mm).

Filmstrip - **Principles of Electromagnetism,** #10003, 330 W. 42nd St., New York: McGraw-Hill Book Company, Inc., Text Films Division (35 mm).

Film - **Principles of Electricity,** 518 17th St., Oakland, Calif.: United States Atomic Energy Commission, San Francisco Operations Office, Office of Public Information (20 minutes, 16 mm, color).

EQUIPMENT:

35 mm filmstrip projector, 16 mm projector, screen, hydrometer, tools for servicing automotive electrical system . . . voltmeter, ohmmeter, starter, battery tester, etc.

PRIMARY REFERENCES:

1) Crouse, William H., **Automotive Mechanics,** New York: McGraw-Hill Book Company, Inc., 1965, Fifth Edition.

2) Frazee, Irving, et al., **Automotive Electrical Systems,** Chicago: American Technical Society, 1956.

3) **Fundamentals of Electricity,** Course 13000.1 Programed Text, Detroit: Ford Division, Ford Motor Company.

4) Toboldt, William K. and Purvis, Jud, **Motor Service's Automotive Encyclopedia,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1965.

I. INTRODUCTION and MOTIVATION

A. Introduce and show film, **Principles of Electricity.** Discuss direct current fundamentals and electron theory.

B. Using filmstrips, **Electric Current Principles** and **Electric Current Measurement,** develop an understanding of electrical measurement.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Electrical fundamentals. 1. Electron theory 2. Voltage, current, resistance 3. Insulators and conductors 4. Circuits 5. Magnetism	1. The electron theory of electricity tricity. 2. Relationships which exist between voltage, current and resistance (Ohm's Law). 3. Insulator and conductor properties. 4. Series and parallel circuits (combinations). 5. Explanation of magnetism.	1. Further eletron theory concepts. 2. Molecular explanation insulators and conductors.
B. Battery. 1. Operation and service 2. Safety considerations	1. The battery as an electrochemical device. 2. Slow and fast recharging cycles. 3. Checking battery conditions with a hydrometer. 4. Checking battery conditions with a load-type battery tester. 5. Care should be taken to avoid: contact with electrolyte, overcharging, and exposure to sparks or flame.	1. Wet and dry cell batteries. 2. Understanding "specific gravity," as applied to battery electrolyte.
C. Lighting and accessory system.	1. Headlight replacement and alignment. 2. Lighting circuit troubleshooting. 3. Light switches and relays. 4. The lighting and accessory system as a parallel circuit. 5. Directional signal switches and circuits. 6. Fuses and circuit breakers.	1. Electric light. 2. The relay as a switch. 3. The fuse as a safety device.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Review Ohm's Law. 2. Working with problems of Ohm's Law relating to the automotive electrical system.	1. Study of the technical vocabulary of electricity.	1. The study of other explanations for electricity which led to the electron theory and its impact on society.
		1. The invention of the Voltaic Cell by Volta.
	1. Reading and understanding pictorial wiring diagrams.	1. The invention of the electric light by Edison. 2. Study of inventions which led to the development of the automobile.

III. APPLICATION

A. Following classroom work, move to laboratory. Describe and trace circuitry on the actual automobile.

B. Demonstrate battery service procedures.

C. Demonstrate headlight alignment and replacement and service procedures for the accessory system.

D. Have students practice service procedures demonstrated.

IV. EVALUATION CRITERIA GUIDELINE

A. Define: volt; ampere; ohm.

B. Describe briefly the construction of a storage battery.

C. What is a conductor? An insulator?

D. What are the basic components of the electrical system?

V. SUMMARY

A. The lighting and accessory system of the automobile is single wire . . . parallel circuitry which uses the chassis as ground.

B. The battery provides the starting power for the automobile. It must be checked and serviced periodically to insure long life.

VI. SUGGESTED TIME and SEQUENCE LISTING

40 minutes . . .	Introduction and showing film, **Principles of Electricity.**
160 minutes . . .	Developing understanding of electrical fundamentals and laboratory demonstrations by instructor.
50 minutes . . .	Work in **Fundamentals of Electricity,** a programed text.
90 minutes . . .	Integrated curriculum concepts.
20 minutes . . .	Summary and evaluation.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Bostwick, Harold S., Green, Lawrence R. and Yergey, William H., **Auto-Mechanics Standard Practice Job Sheets . . . Part Two . . . The Fuel and Electrical Systems.** Milwaukee: Bruce Publishing Company, 1964.

2) Crouse, William H., **Automotive Electrical Equipment.** New York: McGraw Hill Book Company, Inc., 1966, Sixth Edition.

3) Gerrish, Howard H., **Electricity and Electronics,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1964.

INSTRUCTOR'S UNIT PLAN

Unit 14
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Transmissions**

AIM: To understand the basic operation of standard and automatic automotive transmissions and how to perform major standard transmission overhaul and minor automatic transmission diagnosis.

INSTRUCTIONAL AIDS:

Models - Actual transmissions both in and out of the car.

Transparencies - **The Transmission**, #AM-15, AM-36, Philadelphia, Pa.: DCA Educational Products, Inc., 1969.

Charts - **Three-Speed Gear Transmissions**, **Typical Gear Combinations**, Warren, Mich.: Education Relations Section, Public Relations Staff, General Motors Corporation, General Motors Technical Center.

Filmstrip - **Controlled Coupling Hydra-Matic**, Ypsilanti, Mich.: Hydra-Matic Division.

EQUIPMENT:

Standard three and four-speed transmissions, two and three-speed automatic transmissions, pressure gauges, dummy shafts, assortment of snap ring pliers, special tools designed for use with automatic transmissions, automatic transmission holding brackets, overhead projector, filmstrip projector and screen.

PRIMARY REFERENCES:

1) **Chasis Service Manual**, Detroit: Chevrolet Motor Division, General Motors Corporation, 1970.

2) Crouse, William H., **Automotive Transmissions and Power Trains**, New York: McGraw-Hill Book Company, 1959.

3) **Systematic Troubleshooting**, Ypsilanti, Mich.: Hydra-Matic Division, General Motors Corporation, 1969.

4) Toboldt, William K. and Purvis, Jud, **Motor Service's Automotive Encyclopedia**, Homewood, Ill.: The Goodheart-Willcox Co., Inc., 1965.

I. INTRODUCTION and MOTIVATION

Knowledge of transmission fundamentals would enable the serviceman to offer services not usually available in other service stations. Although it is considered complicated, the time spent in learning them is a worthwhile investment.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Transmission maintenance and adjustments	1. Shift linkage adjustments include both column and floor shifters. 2. Special gauge blocks are used. 3. Back drive linkage adjustment. 4. Shift control lever and bracket assembly. 5. This unit is removed to replace reverse lock-out cables in floor shifters. 6. Linkage replacement. 7. Speedometer gear and seal replacement. 8. Tailhousing oil seal replacement. 9. Checking oil level and filling box. 10. 90 weight gear lube is used.	1. Leverage principles. 2. Metals used for transmission gears. 3. Lubrication quality of 90wt. gear lube. 4. Strength of helical and spur gears. 5. Speed and torque relationships. 6. Horsepower curves.
B. Side cover.	1. Removal of linkage arms and cover. 2. Disassembly of shift mechanism and forks. 3. Reassembly and installation.	1. Gear ratios and reversal of rotation.
C. Transmission replacement.	1. Removal and Installation.	
D. Automatic transmission troubleshooting.	1. Servicing: oil pan gaskets, manual levers, oil seal replacement, etc. (Includes anything that can be done under the car). 2. Road test: check all shifts; check oil pressures. 3. Reference to a particular transmission manual will provide necessary information for troubleshooting. 4. Most automatic transmissions are checked for oil while the car is idling and in neutral.	1. Hydraulic couplings and transmission of power. 2. Fluid pressures. 3. Expansion of fluids when heated.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Calibration of speedometers. 2. Computation of speed and torque. 3. Figuring gear ratios for desired output. 4. Plotting speed, torque and horsepower curves.	1. Interpreting graphs. 2. Writing work orders.	1. Development of special alloy steels for longer wear. 2. Why constant mesh transmission replaces sliding gear transmission. 3. Use of transmissions in other forms of vehicles. 4. Two speed racing transmissions.
1. Geometry of shift linkage.	1. Drawing positions of shift arms for reassembly. 2. Reading exploded views of parts.	
1. Measuring torque requirements.	1. Reading manuals for replacement procedures.	
1. Reading pressure gauges. 2. Figuring cost for repair.	1. Reading manuals for troubleshooting and pressure specifications. 2. Interpreting customer explanations of problems.	1. Safety when road testing. 2. Effect of automatic transmissions upon society. 3. B & M Hydro racing automatic.

III. APPLICATION

A. Students should have the opportunity to remove a standard transmission and disassemble it.

B. Students should have the experience of troubleshooting and road testing a faulty automatic transmission.

IV. EVALUATION CRITERIA GUIDELINE

A. How is the oil level of an automatic transmission checked?

B. What type of oil is used in most standard transmissions?

V. SUMMARY

The transmission is the main connector between the engine and the rear wheels. Since skilled men are needed in this area, the serviceman would be very advantaged to be able to service this unit for his customers.

VI. SUGGESTED TIME and SEQUENCE LISTING

220 minutes . . . Presentation and activity.
125 minutes . . . Related concepts.
15 minutes . . . Summary and review.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Hydramatic 400, Principles of Operation.** Ypsilanti, Mich.: Hydra-Matic Division of General Motors Corporation, 1968.

2) **Road Maps - A Guide to Transmission Servicing.** Morton Grove, Ill.: Automatic Transmission Parts, Inc., 1967.

3) **Roto-Hydramatic Diagnosis Guide.** Ypsilanti, Mich.: Hydra-Matic Division General Motors Corporation, 1967.

4) **Turbo Hydramatic Operation and Maintenance.** Pontiac, Mich.: General Motors Corporation Truck and Coach Division, General Motors Corporation, 1966.

INSTRUCTOR'S UNIT PLAN

Unit 15
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Differentials and Rear Axle Assemblies**

AIM: To develop an understanding of the operation and service of the differential and rear axle assemblies.

INSTRUCTIONAL AIDS:

Transparencies - **Rear Axle Assembly**, #AM-16, AM-37, AM-38, AM-39, AM-40, Phila.: DCA Educational Products, Inc., 1970.

Chart - **Rear Axle Assembly**, "Typical Gear Combinations," Warren, Mich.: Educational Relations Section, Public Relations Staff, General Motors Corporation, General Motors Technical Center, 1969 (Charts).

EQUIPMENT:

Rear axle assemblies for on-the-job experiences, propeller shafts, universals, overhead projector and screen.

PRIMARY REFERENCES:

1) **Chassis Service Manual**, Detroit: Chevrolet Motor Division of General Motors Corporation, 1969.

2) Toboldt, William K. and Purvis, Jud, **Motor Service's Automotive Encyclopedia**, Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1965.

I. INTRODUCTION and MOTIVATION

The rear axle assembly is usually of two basic types: the limited slip or positraction rear and the standard rear. Servicing of these units is relatively simple and knowledge in this area should help build the reputation and business of the serviceman.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Maintenance and adjustment.	1. Lubricant should be checked periodically. 2. Positraction rears require special lubricant. 3. Check for oil leaks at differential and axles. 4. Check axle bolts and wheel nuts periodically to insure secure attachment. 5. Rear axle noise is hard to diagnose because it can come from gears or bearings. 6. Bearings usually whine and gear noise will change with speed. 7. Gear backlash adjustment prevents abnormal wear of gears. 8. Close inspection of worn parts will reveal the cause of the failure.	1. Lubricant differences. 2. Transfer of power through gears. 3. Effect of vibrations upon nuts, bolts, and other fasteners. 4. Hypoid gears vs. spur and helical gears. 5. Metal types used for gears, bearings.
B. Component parts replacement.	1. Axle assembly. 2. Axle shaft. 3. Pinion shaft, dust deflector or oil seal. 4. Positraction rears. 5. Manuals should be closely followed for parts replacement because of differences in procedures.	1. Tempering and annealing. 2. Metal used for axles. 3. Clutch disc material.
C. Propeller shaft and universal Joints.	1. Replacement of universal joints. 2. Greasing joints that have grease fittings.	1. Operation of a universal joint. 2. Needle bearings.
D. Rear axle bearings.	1. Located behind backing plate on axles. 2. Will whine very loud if defective. 3. May leak lubricant if not sealed properly.	1. Effect of high temperatures upon bearings.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Measuring amounts of lubricant. 2. Computing ratio. 3. Measuring backlash using feeler gauges and dial indicators.	1. Interpreting wear features into problem solutions. 2. Use of terminology when ordering, speaking.	1. Uses of differentials in other forms of transportation. 2. Cost of production of rear axle assembly parts (quality control). 3. Effect of the automotive industry upon the nation's economic structure. 4. Petroleum refining to obtain heavy greases.
1. Torque readings for bolts. 2. Determining shim thickness for pinion gear.	1. Reading manuals for procedures.	1. Development of the positraction rear and why.
1. Figuring proper angle for driveshafts.	1. Explaining to employees how to remove universal joints.	
1. Ordering bearings by correct number designation.		1. Safety rules involving use of the hydraulic press.

III. APPLICATION

A. Students should work on rear axle assemblies to gain first-hand experience.

B. They should also learn to replace universal joints.

IV. EVALUATION CRITERIA GUIDELINE

A. How are positraction rears different from standard rears?

B. The propeller shaft connects what two units?

C. True or false . . . All types of rears use the same lubricant.

V. SUMMARY

The rear axle assembly and propeller shaft complete the power train. The power is again changed by means of the gear ratio in the differential. Service of this unit will add to the possible sources of work and profits.

VI. SUGGESTED TIME and SEQUENCE LISTING

240 minutes . . . Presentation and activity.
100 minutes . . . Related concepts.
20 minutes . . . Summary and review.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Chassis Overhaul Manual.** Detroit: Chevrolet Motor Division of General Motors Corporation, 1970.

2) **Chassis Service Manual.** Flint, Mich.: Buick Motor Division of General Motors Corporation, 1970.

3) **Chassis Service Manual.** Lansing, Mich.: Oldsmobile Division of General Motors Corporation, 1970.

4) **Chassis Service Manual.** Pontaic, Mich.: Pontiac Motor Division of General Motors Corporation, 1970.

INSTRUCTOR'S UNIT PLAN

Unit 16
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Steering and Front End Alignment**

AIM: To develop an understanding of the principles of steering, suspension and front end geometry and how to adjust, repair or replace the components.

INSTRUCTIONAL AIDS:

Film - **A Doctor's Degree in Driving.** Detroit: General Motors Corporation (10 minutes, 16 mm, sound, B & W).

Film - **Coming Down the Road.** Houston, Texas: Humble Oil and Refining Company (22 minutes, 16 mm, sound).

Film - **Tire Performance.** Buffalo, N. Y.: Dunlop Tire and Rubber Corporation (12 minutes, 16 mm, sound, color).

Charts - **Steering System.** Detroit: General Motors Corporation. Also charts on various services on steering and front end alignment from Bear Manufacturing Company.

Transparencies - Teacher-made transparencies of each component of the front-end system alignment.

EQUIPMENT:

16 mm projector, overhead projector, tripod stand, screen, mock-up suspension systems of "live" cars for students to work on, wheel alignment equipment, static and dynamic tire balancers and tire scuff gauge.

PRIMARY REFERENCES:

1) **Atlas Service Guide, Volume 1.** New York: Humble Oil and Refining Co.

2) **Car Care Manual.** Houston, Texas: Continental Oil Company.

3) Crouse, William H., **Automotive Mechanics.** New York: McGraw-Hill Book Company, Inc., 1965.

4) **Customer Guide to Tire Safety.** New York: Rubber Manufacturers Association.

5) **Motor's Auto Repair Manual.** New York: Motor Publishing Company, 1965-1970.

I. INTRODUCTION and MOTIVATION

Introduce and show film: **A Doctor's Degree in Driving.** Discuss how manual and power steering systems affect driving ease. Discuss how front end alignment affects steering. Describe some of the basic services related to steering and front alignment.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Diagnosing and troubleshooting steering and suspension problem.	1. Symptoms of steering and suspension system troubles: a. Excessive play in systems b. Hard steering c. Car wander on the road d. Car pulls to one side under normal driving or during braking e. Front wheel shimmy f. Front wheel tramp g. Steering kickback h. Tire squeels on turns i. Abnormal tire wear j. Hard or rough ride k. Sway on turns l. Spring breakage m. Sagging springs n. Noises	1. Metallurgy used in suspension systems. 2. Forces acting on springs, shocks, and front end components.
B. Servicing steering linkage and suspensions.	1. Removal, replacement, and adjustment of tie rods 2. Removal and replacement of other linkage parts such as steering idler and upper and lower control arms. 3. Removal and replacement of springs and shocks. 4. Replacement of wheel hub and drum. 5. Adjust steering worm gear and steering shaft and play. 6. Ajust backlash between worm and sector and/or sector shaft (pitman-arm-shaft). 7. Adjust power steering unit. 8. Remove and repair power steering unit.	1. Utilization of gears and levers in the steering and suspension systems.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Figuring service time and cost. 2. Front-end geometry.	1. Diagnose systems and relate to customer the probable reasons for his reported problems or complaints. 2. Dicuss customer complaints with field representative from automobile manufacturer.	1. Importance of recognizing early symptoms of automobile malfunction and having them checked.
1. Determining end play clearance and adjustment settings. 2. Shimming up linkages.	1. Familiarization with steering and suspension nomenclature. 2. Read service and repair manuals on these two systems. 3. Browse through magazines and periodicals related to steering and suspension.	1. Safety records of accidents caused by steering and suspension malfunctions.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
C. Front end alignment and service.	1. Preliminary checks: a. Tire inflation b. Wheel bearings c. Wheel run-out d. Steering knuckles e. Steering linkages f. Wheel balance g. Shock absorbers h. Tracking 2. Alignment services: a. Setting up the car for alignment. b. Measure suspension height c. Check and set caster d. Check and adjust camber e. Measure and correct toe-in f. Check and adjust steering axis inclination g. Measure and adjust toe-out on turns h. Troubleshoot alignment 3. Importance of establishing logical procedures for troubleshooting. 4. Aligning foreign cars.	1. Review previous theory of aligned front end.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Review angles and axes. 2. Measuring accurately.	1. Communicating serious or minor problems to the customer.	1. Time and motion study of mechanics. 2. Responsibility and dependability of mechanics to the service manager and customer. 3. Social image of mechanic.

III. APPLICATION

Students should spend as much time as possible working on automotive steering and suspension problems. Concentrated skill development in checking, removing, repairing, replacing and adjusting should have priority. Advanced skills may be gained after demonstration of basic skills has been given.

IV. EVALUATION CRITERIA GUIDELINE

A. Identify the steering and suspension components.

B. What are symptoms of probable steering failure, Suspension failure?

C. What is the relationship of shocks, springs and steering linkage?

D. What preliminary checks need to be made before an alignment is done?

V. SUMMARY

A. Steering, suspension and front end geometry are important elements in controlling an automobile in motion. Each of these are one of the most intricate and complex systems of an automobile. Regular service and care is essential for the safety of the driver and passengers.

B. Review the front end geometry and its functions.

VI. SUGGESTED TIME and SEQUENCE LISTING

30 minutes . . . Show film: **A Doctor's Degree in Driving.**

20 minutes . . . Demonstrations by instructor.

240 minutes . . . Lab experiences with steering and alignment test and service equipment.

70 minutes . . . Related instruction.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) Crouse, William H., **Automotive Mechanics**, New York: McGraw-Hill Book Company, Inc., 1965.

2) **Mechanical Manual, 1959-1967, Volume 2.** Berkeley, Calif.: National Automotive Service Company, 1967.

3) Murphy, P., **Chilton's Automotive Repair Manual**, Philadelphia: Chilton Company, 1969.

4) **Tire Guide.** Farmingdale, New York: Tire Guide Company (Booklet).

5) Venk, Ernest A. and Billiet, Walter E., **Automotive Fundamentals**, Chicago: American Technical Society, 1967.

INSTRUCTOR'S UNIT PLAN

Unit 17
Lesson 1
Time . . . . . . 6 hours

CLUSTER:	TRANSPORTATION
DIVISION:	AUTOMOTIVE SERVICES II
SUBJECT:	**Brake Systems**
AIM:	To develop an understanding of the different types of automotive brake systems and the servicing skills applied to these systems.

INSTRUCTIONAL AIDS:

Filmstrip - **Basic Brakes,** Dearborn, Mich.: Ford Motor Company (35 mm).

Film - **Hydraulic Brake System,** 704 South Sixth Street, Champaign, Ill. 61822: Visual Aids Service, University of Illinois, Division of University Extension (11 minutes, B & W).

Filmstrips - **Brake Drums and Shoes** #2040-3; **Brake Operating Linkage,** #2040-4; **Hydraulic Brakes,** #2040-5; **Power Brakes,** #2040-6, 2821 E. Grand Blvd., Detroit 48211: Jam Handy Organization.

Chart - **The Hydraulic Brake System,** No. AS01183, 30 E. 42nd Street, New York: National Carbon Company.

Chart - **Hydraulic Brakes,** Detroit: Educational Relations Section, Department of Public Relations, General Motors Corporation.

Loop Films - **Rebuilding the Master Cylinder, Replacing the Bendix Brake Shoes, Bleeding Hydraulic Brakes, Rebuilding Brake Wheel Cylinders,** 1212 Avenue of the Americas, New York: Modern Learning Aids (8 mm).

Transparencies - **Brake Assembly,** AM-17; **Master Cylinder Assembly,** AM-18; **Disc Brake Assembly,** AM-41, 4865 Stenton Avenue, Philadelphia 19144: DCA Educational Products, Inc.

EQUIPMENT:

16 mm projector, 35 mm filmstrip and slide projector, record player, screen, 8 mm loop film projector, assorted brake assemblies, master cylinders, assorted power supplies, chart stands, necessary brake repair tools and shop equipment and brake fluids.

PRIMARY REFERENCES:

1) **Bear Guide to Brake Service,** Rock Island, Ill.: Bear Manufacturing Company, 1966.

2) **Brake Hydraulics, 70-9,** Detroit: Chrysler Motors Corporation (Technical Service Manual).

3) **Brake Service Manual for Cars-Trucks-Buses,** Manheim, Pa.: Grey-Rock Division of Raybestos-Manhattan, Inc., 1965.

4) Crouse, William H., **Automotive Mechanics,** New York: McGraw Hill Book Company, Inc., 1965.

5) **Hydraulic Brake Service Manual,** Rochester, New York: Puritan Company, Inc., 1962.

I. INTRODUCTION and MOTIVATION

Show photograph of traffic light accident caused by faulty brakes (example: parked car rolling down small hill or grade into post or embankment). Have students try to analyze why or how this could happen. Move into demonstrations on brake system services.

II. PRESENTATION of INTEGRATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	RELATED CONCEPTS SCIENCE
A. Principles of automotive braking systems.	1. System consists of master cylinder, wheel cylinders, steel tubing. 2. Brake pedal is pressed causing pressure buildup in master cylinder which pressurizes fluid in tubing and wheel cylinders. Wheel cylinders have pistons that expand brake shoes. 3. Electric brake systems. 4. Pneumatic brake systems. 5. Disc brakes.	1. Boyles,' Pascal's, and Bernoullis' laws. 2. Piston to piston movement ratio. 3. Fluid flow. 4. Analysis of brake fluid. 5. Pneumatic principles. 6. Disc brake principles.
B. Brake fluid reservior and master cylinder.	1. Reservoir is in master cylinder. 2. Provides storage space for reserve fluid to be used as brake lining wears. 3. Master cylinder cap is vented to allow expansion and contraction of the fluid without the formation of a vacuum. 4. Reservoir fluid levels should be maintained for proper operation. 5. *Never spill brake fluid on the car finish!* 6. Bleeding air out of the system. 7. Components of pneumatic and electric systems.	1. Pressure multiplication in the master cylinder. 2. Pressures and vacuums. 3. Effect of air trapped in hydraulic systems.
C. Servicing the brake system.	1. Replace brake shoes and/or linings, and disc pads. 2. Rebuild hydraulic and pneumatic cylinders. 3. Replace master cylinder; (why not rebuild? 4. Repair or replace brake tubing. 5. Replace high pressure hoses. 6. Repair or replace power booster units. 7. Repair pneumatic pressure tank, gauges, and equipment. 8. Adjust brake shoes. 9. Test electrical brake circuits. 10. Repair disc brakes.	1. What causes scored brake drums? 2. How are high pressure hoses different from regular hoses? 3. Brake lining materials. 4. Test equipment operation. 5. Review of electrical and pneumatic principles.
D. Emergency brake.	1. Adjustment of the cables.	1. Mechanical brake system. 2. Leverage.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Figuring pressure and piston area to determine movement ratios. 2. Determination of pressure per unit area. 3. Determining air brake pressures and safety levels.	1. Use of accurate and correct terminology. 2. Interpretation of symptoms into corrective measures. 3. Rapport development with customers. 4. Understand nomenclature differences in the various brake systems.	1. Legal aspects concerning brake repair. 2. Applications of hydraulic systems to automoblies and other transport vehicles. 3. Inspection requirements for brake systems. 4. Development of hydraulic brakes for automobiles. 5. Efficiency of pneumatic, hydraulic, and electric brakes.
1. Figuring cost for and ordering brake fluid and parts. 2. Increasing pressure in the master cylinder. 3. Measuring system capacity for fluid.	1. Reading directions on brake fluid cans (compatibility, etc.). 2. Reading repair manuals. 3. Reading instructions for bleeding brakes.	1. Development of extra emergency reservoir in master cylinders. 2. Refinement and production of brake fluids. 3. Job Study . . . brake repair serviceman.
1. Measuring brake drum diameter (safety limits). 2. Measuring lengths of tubing and tubing diameter. 3. Detemining wheel cylinder diameter safety limits. 4. Turning or "matching" new linings to drum.	1. Informing customers of work that needs to be done. 2. Reading specification and part number charts. 3. Study research booklets available on braking and control systems.	1. New dimensions in braking and control systems for transport vehicles.
1. Measuring cable length for specifications.	1. Reading adjustment procedures.	1. Laws requiring emergency brakes.

III. APPLICATION

Students should have sufficient lab time to experience servicing hydraulic, pneumatic and electric brake systems. Lab time should be spent inspecting, testing-measuring, replacing or repairing and adjusting brake systems on "live" cars or mock-up systems.

IV. EVALUATION CRITERIA GUIDELINE

A. What are advantages and disadvantages of hydraulic, pneumatic and electric brake systems?

B. How do disc brakes work?

C. What symptoms should customers be alert to, which will indicate brake malfunction or failure?

D. How do stopping distances vary with each braking system?

V. SUMMARY

A. Brake systems are one of the most important parts of an automobile because of the safety factor. Brake systems must be carefully maintained and inspected periodically.

B. Point out the variances in driver reaction time and the safe stopping distance needed.

C. Review basic similarities and differences in hydraulic, pneumatic and electric brake systems.

VI. SUGGESTED TIME and SEQUENCE LISTING

30 minutes . . . Introduce and show film: **Hydraulic Brake System**, listed under instructional aids section.

30 minutes . . . Demonstrations o brake systems.

240 minutes . . . Experiences servicing brake systems.

60 minutes . . . Related studies.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Bendix Brake Restoration**, South Bend, Ind: Bendix Automotive Service Division, Bendix Corporation, 1967.

2) **Brake Maintenance Manual**, 6400 Plymouth Ave., St. Louis, Mo.: Wagner Electrical Corporation.

3) **Brake Service Guide**, Bridgeport, Conn.: Raybestos Division, Raybestos-Manhattan, Inc.

4) **Brakes and How They Work**, Detroit: American Brakeblock Division, American Brake Shoe Company.

5) **Delco Moraine Brake Service Manual** Dayton, Ohio: Delco Moraine Division of General Motors Corporation (Booklet).

6) **Delco Moraine Power Brake Service Manual**, Dayton, Ohio: Delco Moraine Division of General Motors Corporation (Booklet).

7) **Quick Reference Brake Service Guide**, Detroit: American Brakeblock Division of American Brake Shoe Company.

8) **Sales Engineering Bulletins**, Bridgeport, Conn.: Raybestos Division of Raybestos-Manhattan, Inc.

9) **Single Piston Disc Brake Service Manual**, Detroit: Delco Moraine Division of General Motors Corporation, 1967.

INSTRUCTOR'S UNIT PLAN

Unit 18
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Body and Fender Work**

AIM: To develop an understanding of the economic value of a good looking automobile and to develop skills in repairing, replacing and painting automotive body parts.

INSTRUCTIONAL AIDS:

Chart - **Body Construction,** Detroit: General Motors Corporation.

Film - **Up From Clay,** Detroit: General Motors Corporation (26 minutes, 16 mm, sound, color).

Film - **The Changing Architecture of the Automobile Body,** Detroit: General Motors Corporation (31 minutes, 16 mm, sound, color).

EQUIPMENT:

16 mm projector and screen, paint spraying equipment, hand and power body tools, variety of finishing materials, sections of auto bodies to work on, soldering supplies oxyacetylene welding equipment and spray booth.

PRIMARY REFERENCES:

1) **Automobile Manufacturers' Shop Manuals.**

I. INTRODUCTION and MOTIVATION

A. Have students guess at the amount of money spent each year on body and fender repair. Perhaps class can make some type of market survey in the community of body and fender repair needs and/or potential.

B. Discuss the value of a car and analyze what creates value and holds the value. Draw attention to importance of attractive looking car as compared to one that looks used regardless of mechanical condition.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Body and fender repair tools and equipment.	1. Special body tools (hand). 2. Pull rods. 3. Body power tools; a. Pneumatic b. Electric 4. Special power straightening benches with hold-down clamps. 5. Body files.	1. Principles of leverage used in hand and power tools.
B. Straightening dents and alignment of parts.	1. Forming with hand tools. 2. Power straightening methods. 3. Body jacks. 4. Special savings in time by use of power straighteners.	1. Review of electric, hydraulic, and pneumatic principles. 2. Metal resiliency.
C. Panel replacement and fitting.	1. Replacement of panels by: a. Bolts b. Welding or brazing 2. Welding procedures. 3. Safety precautions when welding on body. 4. Body panel cutting methods.	1. Principles of gas welding. 2. Fire extinguishing chemicals for automotive body fires. 3. Effects of high temperatures on metals.
D. Filling and patching small areas.	1. Fiber glass patching. 2. Patching by adding sheet of metal over hole or area. 3. Filling with body solder.	1. Fiber glass characteristics. 2. Adhesion chemicals.
E. Preparing surface for painting.	1. Power and hand sanding techniques. 2. Cleaning surface of oils grease, wax, paints, etc. 3. Masking procedures.	1. Principles of metal removal by abrasive paper. 2. Wet and dry sanding. 3. Importance of cleanliness and bonding qualities.
F. Refinishing techniques.	1. Selecting type of finish. a. Lacquer b. Enamel c. Base coat 2. Selecting spray equipment. 3. Air requirements for painting. 4. Spraying procedures and techniques: a. Base coat b. Finish coats	1. Chemical structures of finishes. 2. Atomizing principles. 3. How paint is mixed with air and atomized in the gun.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Determine quantity and quality of hand tools needed. 2. Ordering and pricing tools.	1. Securing bids on tool purchases for service garages.	1. Specific skills needed for body and fender work.
1. Efficiency of power tools over hand tools in terms of time and labor.	1. Training procedures for orienting "old timers" to new power equipment.	1. Impact of portable power equipment on automechanic trades.
1. Selecting and purchasing panels and body parts.	1. Ordering and receiving parts.	1. General safety margins needed when doing automotive work of all types.
1. Compare cost of fiber glass over body solder for covering and filling in areas.		
1. Abrasive grit sizes and classifications. 2. Buying in quantities.		1. Importance of continued care of auto body paint.
1. Setting base price for paint job. 2. Determine satisfactory spray thickness. 3. Economizing on jobs by reducing number of coats, using less expensive paints, etc.	1. Estimating time and cost of paint job for customer.	1. Value of nicely painted car body to potential buyer. 2. Dynamics of colors and their impact on buyers.

L. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
	5. Cleaning and caring for spray equipment. 6. Safety precautions to observe while spraying.	
G. Touching up areas.	1. Matching colors. 2. Determining type of finish. 3. Touch-up techniques.	1. Paint pigments.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
	1. Handling customer complaints on paint jobs.	1. Supplying customers with small spray cans of touch-up paint with purchase of car. 2. Problem of doors swinging against body paint especially in parking lots.

III. APPLICATION

Students should use this information as background knowledge for the development of skills in body repair and painting.

IV. EVALUATION CRITERIA GUIDELINE

A. Name ten or more of the body tools used in straightening dents and creases.

B. What is the value of using power straightening equipment?

C. Name two materials used to fill in or patch areas.

D. What types of paint are used on today's cars?

V. SUMMARY

A. Body repair and refinishing is a very profitable and demanding business. A high level of skill is needed to handle the special tools and processes used in this work.

B. Attention should be given to the refinishing materials and procedures. The importance of safety precautions while welding or painting cannot be over emphasized.

VI. SUGGESTED TIME and SEQUENCE LISTING

30 minutes . . . Introduce class to body repair and refininshing through display and demonstration.

260 minutes . . . Lab experiences in body and fender repair and refinishing.

70 minutes . . . Related studies.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **ABC of Hand Tools,** Detroit: General Motors Corporation (Booklet).

2) **Body Engineering,** Detroit: General Motors Corporation (Booklet).

3) **Designing and Building a Model Car,** Detroit: General Motors Corporation (Booklet).

4) **The Story of Fisher Body,** Detroit: General Motors Corporation (Booklet).

5) Toboldt, William K. and Purvis, Jud, **Motor Service's Automotive Encyclopedia,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1965.

INSTRUCTOR'S UNIT PLAN

Unit 19
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Automotive Tune-Up**

AIM: To develop skill in the procedures for major automotive engine tune-up.

INSTRUCTIONAL AIDS:

Film - **How to Service Spark Plugs,** Flint, Mich.: AC Spark Plug Division of General Motors Corporation (15 minutes, 16 mm, sound, color).

Filmstrip - **20,000 Volts Under the Hood,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation (12 minutes, 35 mm, sound, color).

Filmstrip - **Better Ignition,** Anderson, Ind.: Delco-Remy Division of General Motors Corporation (20 minutes, 35 mm, sound, color).

Filmstrip Kit - **Carburetor Instructor's Program** (997), Rochester, New York: Rochester Products Division of General Motors Corporation (Complete kit of fine colored filmstrips and manual covering engine and carburetor fundamentals, operation and servicing).

Transparencies - **Starting System #636, Charging System #637, Spark and Ignition #638, Ignition System #639,** 2501 Hudson Road, St. Paul, Minn.: Minnesota Mining and Manufacturing Business Products.

Transparencies - **Spark Plugs AM-9, Ignition Distributor AM-28, Ignition Coil and Condenser AM-29,** 4560 East 71st Street, Cleveland, Ohio 44105: Brodhead-Garrett.

EQUIPMENT:

Overhead projector, 16 mm film projector, filmstrip projector and screen.

Operating engines, ignition simulator, electronic test equipment (scope, tach-dwell unit, vacuum gauge and combustion analyzer) and special ignition tools and equipment.

PRIMARY REFERENCES:

1) Allen, Willard A., **Know Your Car,** Chicago: American Technical Society, 1967, Second Edition.

2) Crouse, William H., **Automotive Electrical Equipment,** New York: McGraw-Hill Book Company, Inc., 1966, Sixth Edition.

3) Crouse, William H., **Automotive Mechanics,** New York: McGraw-Hill Book Company, Inc., 1965, Fifth Edition.

4) Frazee, I. and Bedell, E., **Automotive Electrical Systems,** Chicago: American Technical Society, 1967.

5) Glenn, Harold T., **Automechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1962.

6) Kuns, Ray F. (Rev. by Duvall, Jack J.), **Automotive Essentials,** Milwaukee: Bruce Publishing Company, 1966.

I. INTRODUCTION and MOTIVATION

A. Start class by having an electronic engine analyzer attached to a running engine. Call attention to scope pattern and see if class can describe what the pattern tells the mechanic. Explain what can be detected by engine analyzers and the speed and accuracy with which they diagnose problems.

B. Develop student interest by having them begin work on "live" engine ignition systems and the ignition analyzer.

II. PRESENTATION of INTEGRATED CONCEPTS

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Need for major tune-up.	1. Should be done periodically (at least once each year). 2. Difference between engine "running" and engine "performing." 3. Need to coordinate engine systems for better efficiency of operation. 4. Difference between minor and major tune-up.	1. Concept of efficiency.
B. Steps in major tune-up.		
1. Clean and inspect battery cables.	1. Check terminals for corrosion, loose connections and insulation.	1. Cleaning solvents which neutralize battery acid.
2. Test battery.	2. Test specific gravity. May need to test battery ampers and volts.	2. Materials used to prevent terminal corrision.
3. Check starter circuit.	3. Crank engine for specified period of time without starting engine. Check continuity of cranking circuit. Visually check starter for looseness, worn brushes, arcing, starter switch operation, and general wear internally.	3. Specific gravities of water, and sulphuric acid. 4. Concept of electron flow. 5. How volts, amps, and ohms are developed. 6. Concept of torque.
4. Tighten cylinder head bolts and manifold nuts.	4. Use proper torque and sequence. Replace gaskets on engines with overhead rocker arm assemblies.	7. Applying systematic pressure through sequence of tighting nuts. 8. Torquing hot bolts: cold bolts.
5. Test cylinder compression.	5. Test cylinders in order. Record gauge readings. Administer "wet" test and "dry" test.	9. Low compression and high compression.
6. Service spark plugs.	6. Clean, adjust, and/or replace spark plugs. Causes of plug failure. Test plugs under pressure. Indications of engine performance by conditions of plug terminals.	10. Spark plug construction and operation. 11. Effects of compression on spark plug firing. 12. Why poor plug operation affects gas mileage.
7. Check distributor	7. Check contact points, condenser, rotor, and cap. Test advance mechanism. Test and repair or replace parts as needed. Remove distributor from engine and use distributor testor.	13. Concept of dwell angle and contact point operation. 14. Flow of electrons in a circuit. 15. Carbon center wires.
8. Inspect ignition primary and secondary windings.	8. Visual inspection. Check continuity with meter. Test for cracked or worn out wires.	16. Strobe light principles. 17. Scope principles of operation. 18. Scope patterns.
9. Test coil.	9. Insulation, voltage, etc. 6 volt and 12-volt coils.	19. Voltage and current regulation theory.
10. Time ignition.	10. Test ignition tuning and reset if needed.	20. AC and DC production.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Determining life of component parts.	1. Persuade customers of the need for major and minor tune-ups periodically . . . not when something goes wrong.	1. Economic value to consumer of regular maintenance.
1. Determining satisfactory levels of specific gravity in a cell.	1. Understand electric symbols and schematic drawings.	1. Time and motion studies in automechanics.
2. Reading voltage per cell and total voltage.	2. Symbols on bolt head describe hardness characteristics.	2. Manufacturing and assembly line plants.
3. Measuring electrical pressure, electron flow, and resistance.	3. Following instructions pertaining to logical sequence.	3. Assembly line techniques used to assemble and tighten bolts.
4. Determining torque readings from manual and wrench.	4. Cross-referencing spark plug sizes and special characteristics.	4. Automotive tool manufacturers.
5. Pressure gauge readings.	5. Sharing tools and equipment with other mechanics.	5. Advantage of "quality" tools over "economy" tools.
6. Compression tolerances allowed.	6. Terms - TDC and BDC - related to timing an engine.	6. Manufacture of bolts and screws.
7. Spark plug coding systems.	7. Checking manuals for type and location of timing marks.	7. Development of high compression engines.
8. Heat ranges and special purpose plugs.	8. Significance of oscilloscope to mechanic to speed up his work.	8. Standard and replacement equipment in the automotive parts industry.
9. Measuring engine speed with tachometer.	9. Personal care of tools and equipment to extend their usefulness.	9. Setting ignition to individual driving conditions.
10. Measuring contact point gap by feeler gauge or dwell meter.	10. Identify diagnostic procedure to follow if fuel or ignition systems seem to malfunction.	10. Manufacturer's specifications for various geographic locations in the U. S.
11. Meter readings.	11. Convincing customers of need to change carburetor air filer regularly.	11. Need for 12-volt ignition systems because of luxury accessories in modern cars.
12. Advance or retard timing by degrees.	12. Advertising techniques used to sell mufflers and other components.	12. Emergence of electronic analysis and diagnosis in the automotive industry.
13. Measure voltage, circuit continuity, capacitor strenght, distributor advance, etc. on scope.	13. Participation in contest designed to increase products selling.	13. Use of engine and chassis dynamometers for complete automotive analysis.
14. Determining specifications for regulator settings.	14. Providing customer satisfaction by a quality job.	14. 85 to 90 percent of automotive troubles are caused by the ignition system.
		15. Economy of 2-barrel and 4-barrel carburetors.

		RELATED CONCEPTS
INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
11. Test overall ignition system performance.	11. Use engine analyzer with oscilloscope (scopes). Read and interpret scope patterns.	21. Mechanical and electrical fuel pumps. 22. How vacuum is created.
12. Check generator-regulator system.	12. Test generator or alternator output, cut-out relay, current regulator, and voltage regulator. Check fan belt for proper tension and condition.	23. Thermostatic principles of automatic choke operation. 24. Pressure differentials in carburetor circuits cause mixing of air and fuel.
13. Test fuel pump.	13. Clean fuel pump screen and sediment bowl. Test fuel pump for pressure and volume supply. Check for wear. Also check vacuum.	25. Effects of air-fuel ratio on mileage. 26. Causes of hose deterioration.
14. Inspect and adjust carburetor.	14. Check automatic choke for proper operation, throttle linkage for free operation and carburetor hold-down bolts. Adjust idle mixture and RPM screws with engine running.	27. Pressurized fluids and boiling point relationships. 28. Thermostat operation. 29. Dangers of leaky exhaust system.
15. Service carburetor air.	15. Clean washable type or replace throw-away type.	30. Temperature and noise control of combustion gases.
16. Inspect and service cooling system if needed.	16. Check condition of radiator and hoses, and all connections for tightness. Test radiator pressure cap and thermostat for proper operation. Flush cooling system.	31. Principles of hydraulic lifters.
17. Examine exhaust system.	17. Check for leaks, loose connections, or missing parts. Replace parts if needed. Check manifold heat riser valve for proper operation.	
18. Check and adjust valves.	18. Check manual (tappet clearance) and hydraulic valve operation.	
19. Road test car.	19. Check engine performance, proper warm-up, power on acceleration, and general handling of car.	

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
15. Use gauges to determine fuel pressure, volume, and vacuum (if booster is attached to pump). 16. Air-fuel mixture ratios by volume and weight. 17. Estimates of gas mileage lost because of dirty filter. 18. Compute cost of replacement parts for cooling system. 19. Identify pressure readings on radiator caps and figure how hot the antifreeze must get before it will boil. 20. Price differentials in parts for economy cars and luxury cars. 21. Determining price to charge customer for tune-up.		16. Fuel injection systems. 17. Mechanics' profits from sale of parts. 18. Safety precautions of pressurized cooling and fuel systems. 19. Effects of adevrtised "lifetime" parts on consumer buying. 20. Importance of road testing cars after servicing them. Problems with insurance policies and customer over concern.

III. APPLICATION

Students should strive to gain competency in performing a major engine tune-up. The lab experiences should center on practice in tuning and servicing an engine and should stress the use of modern electronic analyzers and gauges.

IV. EVALUATION CRITERIA GUIDELINE

A. What is the purpose of a major engine tune-up?

B. Explain the difference between a major an minor engine tune-up.

C. What does a compression test reveal?

D. What parts are usually replaced in the ignition system during a major tune-up?

E. Why must the ignition and fuel systems be coordinated so accurately?

V. SUMMARY

A. Review the steps involved in a major engine tune-up. Explain why it is necessary to perform all these checks.

B. Review the speed and efficiency of electric analysis. Point out the need for learning to use this equipment because of keen competition and volume of service scheduled.

VI. SUGGESTED TIME and SEQUENCE LISTING

240 minutes . . . Lab experiences in tune-up.

60 minutes . . . Selected films from instructional aids list.

60 minutes . . . Related study in math, science, communications and social studies.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **AC Spark Plug Tune-Up Manual.** Flint, Mich.: AC Spark Plug Division of General Motors Corporation.

2) **Basic Automotive Electricity.** Dearborn, Mich.: Service Department, Ford Division of Ford Motor Company (Free on request).

3) **Better Ignition.** DR-5141, Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Free in quantity).

4) **Champion Service and Installation Manual.** Toledo, Ohio: Champion Spark Plug Company (Free).

5) **Communication.** Chicago: Field Enterprises Educational Corporation, 1967.

6) **Cranking Motors and Series Parallel Switches.** DR-5133C, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

7) **Electrical Fundamentals.** P. O. Box 1919, Detroit: Educational Services, Department of Public Relations, Chrysler Corporation.

8) **Electricity and Wheels.** Detroit: General Motors Corporation.

9) **Facts About Spark Plugs and Engines.** Toledo, Ohio: Champion Spark Plug Company (Free on request).

10) **Fundamentals of Delcotron Generators (Alternators).** DR-5133K, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

11) **Fundamentals of Electricity and Magnetism.** DR-5133A, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

12) **Generators (D. C. Type)**, DR-5133E, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

13) **Ignition Circuit, The**, DR-5133D, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

14) **Introduction to Automotive Electrical System**, DR-9010, Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Free on request in quantities up to fifty).

15) **Master Maintenance (Service Guide)**, Chicago: The Chek-Chart Corporation, 1968.

16) **Transistor Regulators**, DR-51336, Anderson, Ind.: Delco-Remy Division of General Motors Corporation.

17) **Tune-Up Manual 1959-1967, Volume 1**, Berkeley, Calif.: National Automotive Service Co., 1967.

18) **20,000 Volts Under the Hood**, DR-9020, Anderson, Ind.: Delco-Remy Division of General Motors Corporation (Free in quantity).

19) Wetzel, G., **Automotive Diagnosis and Tune-Up**, Bloomington, Ill.: McKnight & McKnight Publishing Company, 1965.

INSTRUCTOR'S UNIT PLAN

Unit 20
Lesson 1
Time . . . . . . 6 hours

CLUSTER: TRANSPORTATION

DIVISION: AUTOMOTIVE SERVICES II

SUBJECT: **Air Conditioning Service**

AIM: To understand the operation of an automotive air conditioning unit and to develop basic diagnostic and repair service skills.

INSTRUCTIONAL AIDS:

Film - **Temperatures Made to Order,** Detroit: General Motors Corporation, Public Relations Staff, Film Library, G. M. Building.

Booklets - **Harrison Heat Exchangers,** Lockport, New York: Harrison Radiator Division.

EQUIPMENT:

Overhead projector, 35 mm projector, 16 mm projector and screen, automotive air conditioners, manifold gauge set, torch-type leak detector, vacuum pump and thermometer.

PRIMARY REFERENCES:

1) **Auto Air Conditioning Service Procedure Manual,** Dallas, Texas: Climatic-Air, 1967.

2) **Chassis Service Manual,** Detroit: Chevrolet Motor Division of General Motors Corporation, 1969.

3) **How Air Conditioning Works,** Dearborn, Mich.: Ford Motor Company, Training Handbook, 1965.

4) Toboldt, William K. and Purvis, Jud, **Motor Service's Automotive Encyclopedia,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1965.

I. INTRODUCTION and MOTIVATION

Automotive air conditioning is rapidly gaining popularity with today's automotive buying public. A mechanic skilled and knowedgeable in air conditioning will be not only an asset to his employer, but himself as well. After viewing the film, **Temperatures Made to Order,** experiences involving cooling and air conditioning should be presented. Air conditioning affects the cooling of an engine because of the additional load and extra radiator space needed.

II. PRESENTATION of INTEGRATED CONCEPTS

RELATED CONCEPTS

INSTRUCTIONAL TOPICS	TECHNICAL CONCEPTS	SCIENCE
A. Principles of operation.	1. Fluids absorb heat while changing from a gas to a liquid. 2. Air conditioner takes heat and moisture from the air.	1. Heat transfer laws. 2. Conduction and convection.
B. Basic components.	1. Compressor. 2. Condenser. 3. Evaporator.	1. Operation of compressor. 2. Charles' Law. 3. Pascal's Law. 4. Boyle's Law.
C. Sight gauge.	1. Used to check level of refrigerant in system.	
D. Discharging system.	1. Attaching manifold pressure gauge. 2. Open high pressure valves then low pressure service valves.	1. Principle of vacuum pump.
E. Evacuation system.	1. Pump system dry with vacuum pump for 20 minutes.	
F. Charging system.	1. Run car at 1500 R.P.M.'s and allow refrigerant to be drawn into the system until the weight of refrigerant is to proper specification. 2. Watch until bubbles disappear.	
G. Compressor oil.	1. Check with dipstick. 2. Discharge system if oil is required.	
H. Safety precautions.	1. Do not have refrigerant exposed to heat or sunlight. 2. Wear safety glasses when working with Freon under pressure. 3. Eliminate all kinks from piping system. 4. Close shutoff valve before connecting any lines or fittings.	1. Characteristics of Freon gas.

TO BE DEVELOPED

MATH	COMMUNICATIONS	SOCIAL STUDIES
1. Reading pressure gauge. 2. Computing inches of vacuum.	1. Determining manufactures specification. 2. Identification of different types of air conditioners.	1. How air conditioning has affected man's industrial output.
1. Determining capacity of system.	1. Explaining malfunctions of system to the customer.	1. Establishing credibility with the customer.
1. Reading tachometer.	1. Writing letters to obtain specification manuals.	1. The development of various air cooling devices such as the fan, etc.
1. Computing evaporation temperature.	1. Interpreting gauge readings; reading service manuals.	1. Popularity of automotive air conditioners.

III. APPLICATION

A. Students should have experiences with a variety of automotive air conditioning units in general.

B. Students should have experiences concerning air-conditioning services such as purging, charging, etc.

IV. EVALUATION CRITERIA GUIDELINE

1. What is a BTU?
2. How can the need for recharging be determined by a visual test?
3. Why must Freon gas be handled carefully?

V. SUMMARY

The air-cooled engine has become increasingly popular in small automobiles. The development of new alloys has made this more realistic. The water-cooled engine, however, is still predominant.

VI. SUGGESTED TIME and SEQUENCE LISTING

240 minutes . . . Presentation and activity.

100 minutes . . . Related concepts.

20 minutes . . . Summary and review.

VII. SUPPLEMENTAL REFERENCES and RESOURCE MATERIAL

1) **Cadillac Shop Manual,** Detroit: Cadillac Motor Car Division of General Motors Corporation, 1970.

2) **Chassis Service Manual,** Flint, Mich.: Buick Motor Division of General Motors Corporation, 1970.

3) **Chassis Service Manual,** Lansing, Mich.: Oldsmobile Division of General Motors Corporation, 1970.

4) **Serviceman's Manual on the Automotive Cooling System,** Wilmington, Del.: E. I. du Pont de Nemours and Company, Inc., 1951.

5) Heitner, Joseph, **Automotive Mechanics,** Princeton, N. J.: D. Van Nostrand Company, 1967.

6) **Service Manual,** Pontiac, Mich.: Pontiac Motor Division of General Motors Corporation, 1970.

7) Stockel, Martin W., **Auto Mechanics Fundamentals,** Homewood, Ill.: The Goodheart-Willcox Company, Inc., 1968.

BIBLIOGRAPHY

Allen, Willard A., **Know Your Car,** Chicago: American Technical Society, 1967, Second Edition.

Atlas Service Guide, Houston: Humble Oil and Refining Company.

Automotive Air Conditioning Service Manual, San Diego: National Automotive Service Company, 1968.

Beeler, Samuel C., **Understanding Your Car,** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1967.

Bricker, Frederick E., **Automobile Guide,** Indianapolis: Theodore Audel & Company, 1967

Crouse, William H., **Automotive Electrical Equipment,** New York: McGraw-Hill Book Company, Inc., 1966.

De Camp, L. Sprague, **Engines: Man's Use of Power,** New York: Affiliated Publishers, 1959.

Drackett, Phil, **Automobiles Work Like This,** New York: Roy Publishers, Inc., 1960.

Frazee, Irving, et al., **Automotive Electrical System,** Chicago: American Technical Society, 1956.

Glenn, Harold T., **Exploring Power Mechanics,** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

Glenn, Harold T., **Power Mechanics Workbook;** based on the textbook: **Expolring Power Mechanics** Peoria, Ill.: Charles A. Bennett Company, Inc., 1967, Second Edition.

GMC Truck Unit Overhaul Manual, #X-7B-07, Pontiac, Mich.: GMC Truck and Coach Division of General Motors Corporation, 1968.

GMC Truck Unit Overhaul Manual, #X-7B-16, Pontiac, Mich.: GMC Truck and Coach Division of General Motors Corporation, 1970

Heitner, Joseph, **Automotive Mechanics,** Princeton, N. J.: D. Van Nostrand Company, Inc., 1967.

Hyde, Margaret O., **Driving Today and Tomorrow,** New York: McGraw-Hill Book Company, Inc., 1965.

Kuns, Ray F. and Duvall, Jack, **Automotive Essentials,** Milwaukee: Bruce Publishing Company, 1966.

Mechanical Manual 1959-1967, Volume 2, Berkeley, Calif.: National Automotive Service Company, 1967.

Motor's Auto Repair Manual, New York: Motor Publishing Company, 1969, 32nd Edition.

Motor's Auto Wiring Diagrams, New York: Motor Publishing Company, 1969.

Motor's Flat Rate Manual, New York: Motor Publishing Company, 1969, 41st Edition.

Motor's Quick Service Manual, New York: Motor Publishing Company, 1969.

Motor's Truck Repair Manual, New York: Motor Publishing Company, 1969.

Murphy, P., **Chilton's Automotive Repair Manual,** Philadelphia: Chilton Books, 1969.

Occupational Outlook Handbook, "Gasoline Service Station Attendants," Washington, D. C.: United States Government Printing Office.

Petersen, Robert E., **The Complete Book of Hot Rodding,** Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1959.

Reck, Franklin M., **The Romance of American Transportation,** New York: Thomas Y. Crowell Company, 1962.

Rogers, Don E., **Engines: Progress and Power,** Racine, Wis.: Whitman Publishing Company, 1962.

SC-337 Instructional Guide for Auto Mechanics, Los Angeles: Senior High School Industrial Education, Los Angeles City Schools, Division of Instructional Services, 1959, Revised Edition.

Service Bullitens #10, 11, 101, 102, Dixon, Ill.: Shurhit Automotive Parts, Warner-Motive Division of Borg-Warner Corporation, 1966 (All deal with alternators).

Serving Homes, Industry, Transportation, Dayton, Ohio: Delco Products Division of General Motors Corporation.

Shellubrication Specification Guide Book, Shell Oil Company, 1969.

Toboldt, William K. and Johnson, Larry, **Motor Service's Automotive Encyclopedia.** Homewood, Ill.: The Goodheart-Willcox Company, Inc., Revised 1968.

Transmission Manual 1957-1966. Volume 3, Berkeley, Calif.: National Automotive Service Company, 1966.

Tune- Up Manual 1959-1967. Volume 1, Berkeley, Calif.: National Automotive Service Company, 1967.

Venk, Ernest A. and Billiet, W. E., **Automotive Fundamentals.** Chicago: American Technical Society, 1967.

Wetzel, Guy F., **Automotive Diagnosis and Tune-Up.** Bloomington, Ill.: McKnight & McKnight Publishing Company, 1965.

Worthington, Robert M., Margules, Morton and Crouse, William H., **General Power Mechanics.** New York: McGraw-Hill Book Company, Inc., 1968.